PACIFIC SALMON COMMISSION
JOINT CHINOOK TECHNICAL COMMITTEE

# ANNUAL REPORT OF CATCH AND ESCAPEMENT FOR 2012

REPORT TCCHINOOK (13)-1

July 2013

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# List of Acronyms and Abbreviations

| | |
|---|---|
| **AABM** | Aggregate Abundance Based Management |
| **ADF&G** | Alaska Department of Fish and Game |
| **Agreement** | June 30, 1999 PST Annex and the Related Agreement |
| **AUC** | Area-Under-the-Curve |
| **BC** | British Columbia |
| **CBC** | Central British Columbia (Kitimat to Cape Caution) |
| **CDFO** | Canadian Department of Fisheries and Oceans |
| **CI** | Confidence Interval |
| **COLR** | Columbia River |
| **CNR** | Chinook Non-Retention |
| **CR** | Chinook Retention |
| **CRITFC** | Columbia River Intertribal Fish Commission |
| **CRFMP** | Columbia River Fish Management Plan |
| **CTC** | Chinook Technical Committee |
| **CV** | Coefficient of Variation |
| **CWT** | Coded Wire Tag |
| **CY** | Calendar Year |
| **ESA** | U.S. Endangered Species Act |
| **FN** | First Nations |
| **FNC** | First Nations Caucus |
| **FR** | Fraser River |
| **FSC** | Food, Social & Ceremonial |
| **GH** | Grease Harbor |
| **GMR** | Genetic Mark Recapture |
| **GW** | Gitwinksihlkw |
| **IM** | Incidental Mortality |
| **ISBM** | Individual Stock Based Management |
| **JDF** | Juan De Fuca |
| **LAT** | Low Abundance Threshold |
| **LC** | Landed Catch |
| **LGS** | Lower Strait of Georgia |
| **LIM** | Legal Incidental Mortality |
| **MA** | Management Agreement |
| **MOC** | Mid-Oregon Coast |
| **MR** | Mark–Recapture |
| **MRE** | Mature-Run Equivalent |
| **MSH** | Maximum sustainable catch |
| **MSY** | Maximum Sustainable Yield for a stock, in adult equivalents |
| **NA** | Not Available |
| **NC** | North Coastal |
| **NBC** | Northern British Columbia (Dixon Entrance to Kitimat including Queen Charlotte Islands) |
| **NMFS** | National Marine Fisheries Service |
| **NOC** | North Oregon Coast |
| **NWIFC** | Northwest Indian Fisheries Commission |
| **ODFW** | Oregon Department of Fish and Wildlife |
| **ORC** | Oregon Coast |
| **PS** | Puget Sound |
| **PSC** | Pacific Salmon Commission |
| **PST** | Pacific Salmon Treaty |
| **QIN** | Quinault Nation |
| **QCI** | Queen Charlotte Islands |
| **SE** | Standard Error |
| **SIM** | Sublegal Incidental Mortality |
| **SMSY** | Escapement producing MSY |
| **SEAK** | Southeast Alaska Cape Suckling to Dixon Entrance |
| **SPAS** | Stratified Populations Analysis System |
| **SSP** | Sentinel Stocks Program |
| **SRA** | Stock-Recruit Analysis |
| **SUS** | Southern U.S. |
| **SWVI** | Southwest Vancouver Island |
| **TBR** | Transboundary Rivers (Alsek, Taku, Stikine) |
| **TM** | Total Mortality |
| **UAF** | University of Alaska Fairbanks |
| **UGS** | Upper Strait of Georgia |
| **UMT** | Upper Management Threshold |
| **UMSY** | Exploitation Rate at MSY |
| **USFWS** | U.S. Fish & Wildlife Service |
| **U.S.** | United States |
| **WAC** | Washington Coast |
| **WCVI** | West Coast Vancouver Island excluding Area 20 |
| **WDFW** | Washington Department of Fish and Wildlife |

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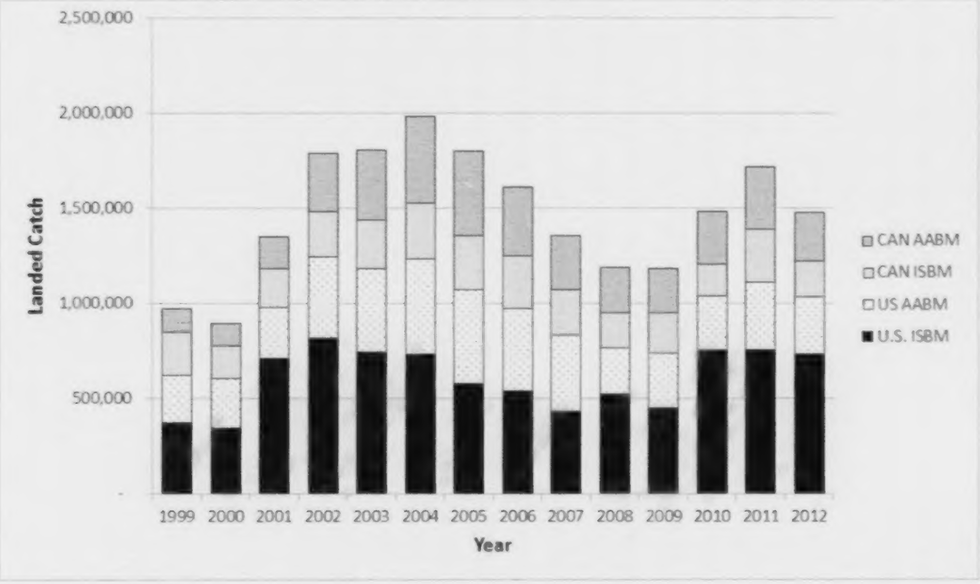
# EXECUTIVE SUMMARY

The Pacific Salmon Treaty (PST) requires the Chinook Technical Committee (CTC) to report annual catch and escapement data for Chinook salmon. The CTC provides an annual report to the Pacific Salmon Commission (PSC) to fulfill this obligation as agreed by Canada and the U.S. under Chapter 3 of the Treaty. This report contains four sections: Chinook salmon catch, escapements, a new section on stock status that provides an indication of stock performance in the context of management objectives, and a summary of the Sentinel Stocks Program for 2012.

Annual catch data for the report is compiled by Canada and the U.S. for their respective jurisdictions within the PST area according to fishery regimes, regional locations, and gear type with estimates of incidental mortality (IM) . Section 1 summarizes fishery catches by region and available estimates of incidental mortality (IM) by fishery in 2012, with accompanying commentary on the fisheries, management, and derivation of IM. Landed catch (LC) is fully reported in the appendices for each geographic area covered under the PST; a summary for all PSC AABM and ISBM fisheries, from 1999 to 2012, is provided in the figure below. In addition, time series of available IM estimates were added this year in Appendix A for individual fisheries. Appendix A also includes a coastwide summary of the historical time series of LC, IM, and their sum, total mortality (TM), across all AABM and ISBM fisheries.

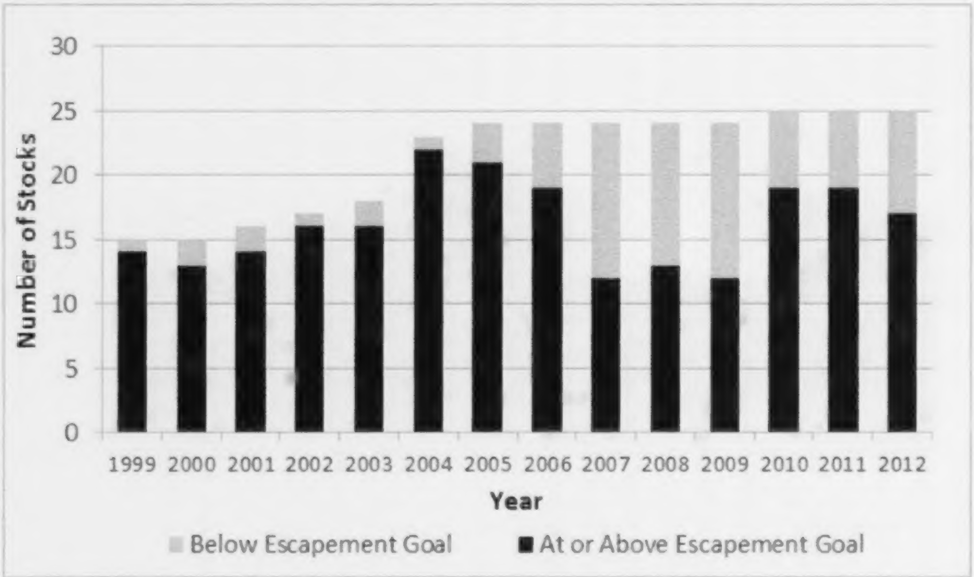


*Estimates of landed catch for U.S. and Canada AABM and ISBM fisheries 1999–2012.*

The preliminary estimate of total LC of Chinook salmon for all PSC fisheries prosecuted in 2012 was 1,474,149, of which 1,029,554 and 444,595 were taken in U.S. and Canadian fisheries, respectively. The estimated total IM associated with this harvest is 211,881 nominal Chinook salmon. The TM for all PSC fisheries in nominal fish was 1,686,030 Chinook salmon, of which 1,181,283 were taken in U.S. fisheries and 504,746 in Canadian fisheries. For U.S. fisheries, 71% of the LC and 69% of TM occurred in ISBM fisheries; in Canada, 43% of the LC and 44% of TM occurred in ISBM fisheries. For some component sport fisheries, 2012 LC and IM estimates are not yet available.

Section 2 includes an assessment of escapement for stocks with CTC accepted goals, and escapement data through 2012 for all PST escapement indicator stocks. The escapements of 50 naturally spawning escapement indicator stocks are reviewed annually, along with the results from the Sentinel Stocks Program (SSP). The CTC will continue to review escapement goals for stocks as they are provided by respective agencies. Biologically-based escapement goals have been accepted by the CTC for 25 of the 50 escapement indicator stocks/stock aggregates. For 12 of these, the escapement goal is defined as a range; for the remaining 13, the escapement goal is the point estimate of $S_{MSY}$ (escapement producing maximum sustained yield). Annual escapement that is more than 15% below the lower end of the range or the $S_{MSY}$ point estimate is of particular concern.

From 1999 to 2011, the percentage of stocks that met or exceeded escapement goals or goal ranges has varied from 50% to 96%. In 2012, 17 of 25 stocks (68%) met or exceeded escapement objectives. Of the eight stocks below goal, three stocks (Chilkat, Andrew, and Chickamin) were within 15% of the target goal; five stocks (Situk, Unuk, Alsek, Harrison, and Cowichan) were more than 15% below goal.

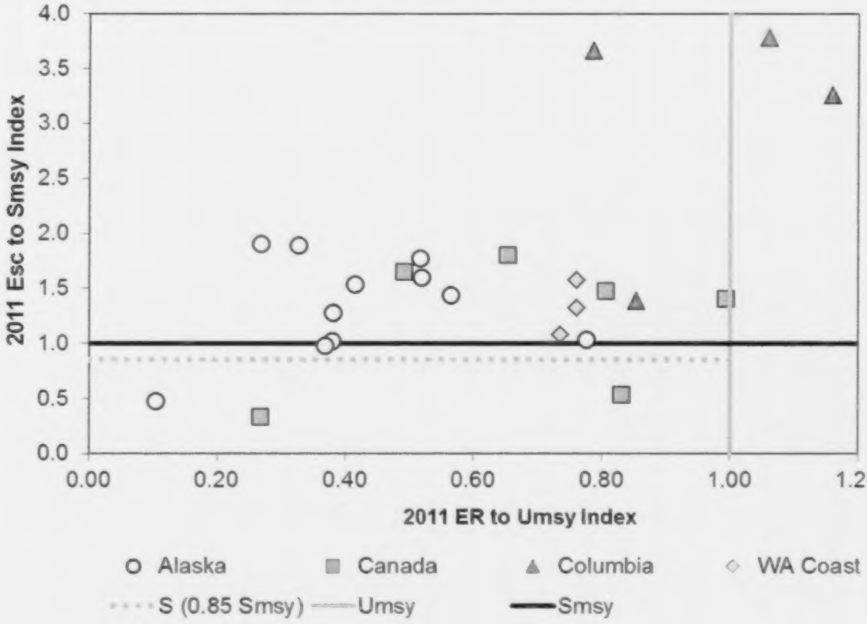


*Number and status of stocks with CTC-accepted escapement goals for 1999–2012.*

The CTC evaluated the performance of the stock groups against the criteria for triggering additional management action in regards to PST Chapter 3, Paragraph 13 (c), based upon observed escapements and exploitation rates through 2012 and stock forecasts for 2013. No stock groups listed in Attachment I–III met the criteria for triggering additional management action for the 2011 and 2012 observed values. The 2012 observed escapement and 2013 forecast values indicate that one stock group (Fraser late, i.e., Harrison River) potentially meets the flagging criteria for triggering Paragraph 13 action, however 13(g) notes no further reduction will be taken in the West Coast Vancouver Island (WCVI) fishery unless otherwise agreed by the PSC. Note that ISBM obligations for 2012 cannot be calculated for some stocks until 2014 because of a delay in required coded wire tag (CWT) data under current fishery monitoring programs.

No stocks in Attachments I-III of the PST with an agreed escapement objective were more than 15% below the management objective in both 2011 and 2012. However, only five of the 10 different stock groups in Attachments I–III have stocks with CTC-accepted management objectives that can be evaluated against Paragraph 13 (c) criteria, and 11 of these stocks had forecasts available for 2012. The CTC has identified a need to develop management objectives (higher priority) and forecast capabilities (lower priority) for more of the stocks and stock groups included in Attachments I–III to improve the efficacy of Paragraph 13.

A synoptic evaluation of stock status is presented in Section 3 for each escapement indicator stock for each region, summarizing the performance of those stocks relative to established goals over time. This evaluation draws upon the catch information in Section 1, escapement information in Section 2, and exploitation rates and other information to evaluate the status of stocks in a region. Synoptic plots present both the current status of stocks and the history of the stocks relative to PST management objectives to clearly summarize the performance of the stocks and fisheries management relative to established or potential goals. A synoptic summary figure for 24 stocks with 2011 data shows that the majority of stocks were in the safe zone. None of the stocks were in the high risk zone, however three stocks were in the low escapement and low exploitation zone. Two stocks had experienced high exploitation, but their escapements exceeded the escapement goal objective. When stock status was examined by region there was not a strong regional pattern, other than for Washington Coast.



*Synoptic summary by region of stock status for stocks with escapement and exploitation rate data in 2011 (escapement and exploitation rate data for each stock was standardized to the stock-specific escapement goal and* $U_{MSY}$ *reference points).*

A summary of the 2012 SSP is presented in Section 4. The goal of the SSP is to improve estimates of escapement for Chinook salmon stocks in the following five coastal areas: Northern British Columbia (NBC), Fraser River, WCVI, Puget Sound, and North Oregon Coast (NOC) to a level that meets or exceeds bilateral assessment accuracy and precision standards. The 2012 season is the fourth year of the program. In 2012, the PSC approved $2,157,600 in funding for 14 projects. The funded projects estimated escapements for stocks in the Nass, Skeena (two projects), Harrison, Chilko, South Thompson, Burman, WCVI, Snohomish, Stillaguamish, Green, Siltez, and Nehalem rivers and to develop a statistical framework for escapement estimation in the WCVI. Escapement estimates and methods used to obtain those estimates are described in Section 4 and Appendix C for each of the funded programs.

The CTC has been working to develop bilateral data standards for the minimum (or desired) assessment program required to effectively implement the 2009 Agreement. For escapement indicator stocks, asymptotically accurate (unbiased) and a CV of 15% are the CTC data standards for escapement estimates. These standards were adopted in 2008 and documentation of that action is provided in Appendix D. In June 2013, the CTC adopted standards for escapement goals. A technical note (CTC Technical Note 1301) on maximum sustained yield (MSY) or other biologically-based escapement goals is provided in Appendix E.

# 1 CHINOOK SALMON CATCH

The 1999 and 2009 Agreements substantially changed the objectives and structure of the PSC Chinook salmon fisheries. The 1999 Agreement eliminated the previous ceiling and pass-through fisheries and replaced them with Aggregate Abundance Based Management (AABM) and Individual Stock Based Management (ISBM) fisheries. The 2009 Agreement defines catch limits for Chinook salmon AABM fisheries while ISBM fisheries are limited by adult equivalent mortality rates for stocks not meeting their escapement objectives. This report assesses landed catch (LC), incidental mortality (IM) and total fishing mortality (TM) among all fisheries, both those targeting Chinook salmon (Chinook Retention, CR) as well as those directed at other salmon species (Chinook Non-Retention, CNR); all are reported here as occurring within the three AABM and the Canada and U.S. ISBM fisheries. For 2012, estimates for the three AABM fisheries are presented by gear sector in Table 1.2.1 and Table 1.2.2.2, and similar estimates for ISBM fisheries of Canada and the U.S. are summarized in Table 1.3.1 and Table 1.3.3, respectively. A summary of the estimated LC, IM, and TM for Chinook salmon in all PST AABM and ISBM fisheries is presented in Table 1.4.

The CTC started reporting IM within AABM fisheries in 2004 (CTC 2004a) and within most ISBM fisheries in 2005 (CTC 2005). The current reporting of LC and IM in all PST fisheries provides an opportunity to present a comprehensive overview across all PST fisheries that harvest Chinook salmon. Commentary is provided to explain fisheries, management, and derivation of estimates of IM. Historical LC, IM, and TM data are given in Appendix A.

## 1.1 Review of Aggregate Abundance Based Management Fisheries

AABM fisheries for Chinook salmon are managed to an allowable catch associated with each year's abundance index in Table 1 of the Agreement. AABM fisheries are mixed stock salmon fisheries that intercept and catch migratory Chinook salmon from many stocks. The AABM fisheries (PST, Annex IV, Chapter 3, paragraph 2) are:

1) Southeast Alaska (SEAK) All Gear,
2) Northern British Columbia (NBC) Troll and Queen Charlotte Islands (QCI) sport, and
3) West Coast Vancouver Island (WCVI) Troll and Outside Sport.

Catches for these three fisheries are reported in Table 1.1.

*Table 1.1.–Annual catches and hatchery add-ons for AABM fisheries, expressed in thousands of Chinook salmon. The treaty catches do not include the hatchery add-on or exclusions (see Appendix A.1).*

| | **Southeast Alaska (T, N, S)** | | | **Northern British Columbia (T), Queen Charlotte Islands (S)** | | **West Coast Vancouver Island (T, S)** | |
|---|---|---|---|---|---|---|---|
| | **Treaty Catch** | | **Hatchery Add-on** | **Treaty Catch** | | **Treaty Catch** | |
| **Year** | **Limit[1]** | **Observed** | | **Limit[1]** | **Observed** | **Limit[1]** | **Observed** |
| 1999 | 184.2 | 198.8 | 47.7 | 126.1 | 86.7 | 107.0 | 36.4 |
| 2000 | 178.5 | 186.5 | 74.3 | 123.5 | 31.9 | 86.2 | 101.4 |
| 2001 | 250.3 | 186.9 | 77.3 | 158.9 | 43.5 | 145.5 | 117.7 |
| 2002 | 371.9 | 357.1 | 68.2 | 237.8 | 150.1 | 196.8 | 165.0 |
| 2003 | 439.6 | 380.2 | 57.2 | 277.2 | 191.7 | 268.9 | 175.8 |
| 2004 | 418.3 | 417.0 | 76.0 | 267.0 | 241.5 | 209.6 | 216.6 |
| 2005 | 387.4 | 390.3[3] | 65.2[3] | 240.7 | 243.6 | 179.7 | 202.7 |
| 2006 | 354.5 | 361.3[3] | 48.5[3] | 200.0 | 216.0 | 145.5 | 146.9 |
| 2007 | 259.2 | 328.0[3] | 68.9[3] | 143.0 | 144.2 | 121.9 | 139.2 |
| 2008 | 152.9 | 172.0[3] | 66.2[3] | 120.9 | 95.6 | 136.9 | 143.8 |
| 2009[2] | 176.0 | 227.7[3] | 62.3[3] | 139.1 | 109.5 | 91.3 | 124.6 |
| 2010 | 215.8 | 229.4[3] | 54.3[3] | 160.4 | 136.6 | 142.3 | 136.8 |
| 2011 | 283.3 | 292.0[3] | 64.5[3] | 186.8 | 122.7 | 134.8 | 204.2 |
| 2012 | 205.1 | 241.0 | 53.2 | 149.5 | 120.3 | 113.8 | 134.5 |
| 2013 | 176.0 | | | 143.0 | | 115.3 | |

*Note*: T + Troll, N = Net and S = Sport fisheries.

[1] Allowable treaty catches correspond to the first post season abundance indices for 1999 to 2012 and the pre-season abundance indices for 2013.

[2] 2009 was the first year of implementation of the 2009 Agreement.

[3] Values changed because the method used to partition gillnet catch into large and non-large fish changed.

### 1.1.1 Southeast Alaska Fisheries

The SEAK Chinook salmon fishery is managed to achieve the annual all-gear PSC allowable catch associated with the pre-season abundance index generated by the CTC Chinook Model each spring. The catch is allocated through regulations established by the Alaska Board of Fisheries. This plan establishes allocations among troll, net, and sport fisheries. The current allocation plan reserves 4.3% of the total all-gear catch for purse seine, 2.9% for drift gillnet and 1,000 fish for set gillnet fisheries. After the net quotas are subtracted, 80% of the remainder is allocated for commercial troll and 20% for sport fisheries. The commercial troll and net fisheries are managed in-season according to procedures outlined in gear-specific management plans. Sport fishery bag and possession limits as well as annual limits are established prior to the season based on the pre-season abundance index. Regulatory history and maps for each SEAK fishery are described in CTC 2004b.

In addition, the SEAK fisheries are managed for:

1) An Alaska hatchery add-on estimated from CWT sampling. The add-on is the total estimated Alaskan hatchery catch, minus 5,000 base-period Alaskan hatchery catch, and minus the standard error (SE) for the total estimated Alaskan hatchery catch.
2) An exclusion of wild Chinook salmon originating from the Situk, Stikine and Taku rivers, when appropriate according to Chapter 1 (Transboundary Rivers) of the 2009 Agreement.
3) Compliance with provisions established by the National Marine Fisheries Service (NMFS) in accordance with the U.S. Endangered Species Act (ESA).
4) Consistency with the provisions of the PST as required by the Salmon Fishery Management Plan of the North Pacific Fishery Management Council that was established by the U.S. Magnuson-Stevens Act.

The SEAK 2012 pre-season abundance index of 1.52 provided for an all-gear PST allowable catch of 266,800 Chinook salmon. The preliminary total all-gear catch in 2012 was 295,395 with a PST catch of 241,015, an Alaska hatchery add-on of 53,205, and a terminal exclusion catch of 1,175 Chinook salmon. Historical SEAK Chinook salmon catch numbers for 1975 to 2012 are included in Appendix A.1.

### 1.1.1.1 *Troll Fisheries Catch*

The troll fishery accounting year began with the start of the winter fishery on October 11, 2011 and ended with the summer fishery in September 2012. The winter troll fishery continues until 45,000 Chinook salmon are caught, or through April 30, whichever is earlier. In 2012, the winter troll fishery was open through April 27. The spring fishery, which targets Alaska hatchery-produced Chinook salmon, was conducted from May 1 to June 30 in a total of 31 spring areas and five terminal harvest areas. While there is no ceiling on the number of Chinook salmon harvested in the spring fisheries in aggregate, the take of treaty Chinook salmon is managed in consideration of the percentage of Alaska hatchery fish taken in each individual fishery area. The 2012 summer troll fishery included two Chinook salmon retention periods, from July 1 to July 9 and August 11 to September 8. In recent years, a small but increasing portion of the troll fleet has targeted chum salmon from mid-June through August, resulting in a decrease in effort directed at Chinook and coho salmon (Skannes et al. 2013).

In 2012, the troll fishery harvested 209,392 Chinook salmon, which included 21,234 Alaska hatchery fish. There was an Alaska hatchery add-on of 17,193 and a Transboundary Rivers (TBR) exclusion of 343 fish, and subtraction of these from the total harvest results in a total of 191,856 PST fish. The winter fishery harvested 47,888 fish, of which 5,897 were from Alaska hatcheries and 43,149 were PST fish. The spring fishery caught a total of 25,563, of which 10,351 were Alaska hatchery fish and 16,773 were PST fish. The total summer catch was 135,941, of which 4,985 were from Alaska hatcheries and 131,934 were PST fish (Table 1.1.1.1).

*Table 1.1.1.1.–Harvest of Chinook salmon in Southeast Alaska by gear type in 2012.*

| Gear | Total Catch | Alaska Hatchery Catch | Alaska Hatchery Add-on | Terminal Exclusion Catch[1] | AABM Catch[4] |
|---|---|---|---|---|---|
| **Troll** | | | | | |
| Winter | 47,888 | 5,897 | 4,739 | 0 | 43,149 |
| Spring | 25,563 | 10,351 | 8,447 | 343 | 16,773 |
| Summer | 135,941 | 4,985 | 4,007 | 0 | 131,934 |
| Troll subtotal | 209,392[2] | 21,234 | 17,193 | 343 | 191,856 |
| | | | | | |
| **Sport[3]** | 46,520 | 11,700 | 10,071 | 0 | 36,449 |
| | | | | | |
| **Net** | | | | | |
| Set Net | 382 | | | 0 | 382 |
| Drift gillnet | 17,956 | 12,316 | 10,822 | 832 | 6,302 |
| Seine | 21,145 | 15,273 | 15,120 | 0 | 6,025 |
| Net subtotal | 39,483 | 27,590 | 25,942 | 832 | 12,709 |
| | | | | | |
| **Total** | 295,395 | 60,523 | 53,205 | 1,175 | 241,015 |

[1] Terminal exclusion catch is a result of the harvest sharing arrangement on the Taku and Stikine rivers.

[2] Includes 11 fish confiscated by the State of Alaska due to illegal fishing.

[3] Preliminary values until mail-out survey results are available.

[4] Treaty catch is the total catch minus Alaska hatchery add-on minus terminal exclusion catch. Totals may not equal the sum of the individual values due to rounding.

### 1.1.1.2 *Net Fisheries Catch*

There are three types of commercial net fisheries conducted in SEAK: purse seine, drift gillnet, and set gillnet. With the exception of directed gillnet harvests of Chinook salmon in SEAK terminal areas as provided in the Transboundary river chapter of the PST, harvests of Chinook salmon in the net fisheries are incidental to the harvest of other species. The 2012 total net catch was 39,483 Chinook salmon, which included 27,590 Alaska hatchery fish. There was an Alaska hatchery add-on of 25,942 and a TBR exclusion of 832, resulting in a PST catch of 12,709 (Table 1.1.1.1).

The purse seine fishery is open from mid-June through early fall and is limited to specific areas and time periods established in season by emergency order (Davidson et al. 2011b). In 2012, a total of 21,145 Chinook salmon, which included 15,273 Alaska hatchery fish and an Alaska hatchery add-on of 15,120 resulting in a PST catch of 6,025.

The drift gillnet fishery usually opens in late June, unless directed fisheries are implemented in May to target surplus production of Chinook salmon bound for the Taku and Stikine rivers, (Davidson et al. 2011a) as detailed in Chapter 1 of the 2009 Agreement. In 2012, surplus production and associated allowable catches were identified in both the Taku and Stikine rivers based on pre-season forecasts, and the allowable catches were large enough to implement limited directed commercial fisheries in Canada and sport fisheries in the U.S. However, the first in-season forecast updates for the Taku and Stikine rivers suggested run sizes were too low to provide for additional openings.

Overall, the drift gillnet fishery is limited to five traditional areas within the region and time periods are established in season by emergency order. The drift gillnet fishery caught a total of 17,956 Chinook salmon, including 12,316 Alaska hatchery fish. There was an Alaska hatchery add-on of 10,822 and a TBR exclusion of 832, resulting in a PST catch of 6,302.

The set gillnet fishery is managed to catch no more than 1,000 PST Chinook salmon, a limit which is based on a historic average. This fishery is open during the late spring and summer in the Yakutat area. The 2012 set gillnet fishery caught 382 Chinook salmon, all of which were PST fish.

#### *1.1.1.3 Sport Fishery Catch*

Sport catches are monitored in season by creel surveys throughout the region, and sampling programs are in place to recover tags from coded wire tagged Chinook salmon and coho salmon. The number of Alaska hatchery fish caught is estimated from the CWTs collected by the sampling program. Preliminary sport catch estimates are computed from the creel surveys while final sport catch estimates are computed from a mail-out survey and are available one year after the fishery occurs. In 2012, Chinook salmon regulations for the sport fishery allowed for a three fish daily bag limit and no annual limit for residents. Non-resident anglers had a one fish daily bag limit except during May, when the bag and possession limit was two. Nonresident anglers had an annual limit of four Chinook salmon. The minimum size limit of 71 cm (28 inches) in total length was in effect for both resident and non-resident anglers throughout the season. In some designated harvest areas near hatchery release sites, bag and possession limits and annual limits were liberalized to provide increased catches of returning Alaska hatchery Chinook salmon. The preliminary 2012 total sport Chinook salmon catch was 46,520 with an estimate of 11,700 Alaska hatchery fish. There was an Alaska hatchery add-on of 10,071 fish, resulting in a PST catch of 36,449 Chinook salmon (Table 1.1.1.1).

### 1.1.2 British Columbia Fisheries

Under the 1999 PST Agreement, AABM regimes were implemented to constrain catch. This agreement extended through 2008 and was renewed in the 2009 PST Agreement that extends through 2018. The NBC AABM fishery includes NBC troll catch in Statistical Areas 1–5 and QCI sport catch in Statistical Areas 1 and 2. The total NBC AABM catch in 2012 was 120,306. The WCVI AABM fishery includes the WCVI commercial and First Nations (FN) troll and a portion of the WCVI sport fishery (defined below). The total WCVI AABM catch in 2012 was 134,468 (Table 1.1.2). Troll catches from 1996 to 2004 have been updated with data from Canadian Department of Fisheries and Oceans (CDFO 2009; Appendix A).

*Table 1.1.2.–Harvest of Chinook salmon by gear for Canadian AABM fisheries in 2012.*

| AABM Fishery | NBC | WCVI |
|---|---:|---:|
| Northern BC Troll (Area F) | 80,257 | |
| WCVI Troll (Area G) | | 55,530 |
| FSC Troll | | 5,000 |
| Maanulth Troll | | 2,232 |
| T'aaq-wiihak Troll | | 6,292 |
| Sport | 40,050 | 65,414 |
| **Total** | **120,307** | **134,468** |

### 1.1.2.1 *Northern British Columbia AABM*

The total NBC AABM catch (troll plus sport) between October 1, 2011 and September 30, 2012 was 120,307 Chinook salmon (Table 1.1.2).

#### 1.1.2.1.1 Northern British Columbia Troll Fishery Catch

The NBC troll fishery landed 80,257 Chinook salmon in 2012. The NBC troll fishery was opened for Chinook salmon fishing from June 21 to July 15, July 20 to August 11, and September 4 to September 30. The entire 2012 NBC troll fishery was conducted under a system of individual transferable quotas. A total of 282 vessels were licensed but catch was conducted by 156 vessels, as much of the quota was transferred. Barbless hooks and revival boxes were mandatory in the troll fishery and the minimum size limit was 67 cm (26.4 in). No troll test fisheries were conducted in 2012. A ribbon boundary around Langara Island and from Skonun Point to Cape Knox on Graham Island excluded the commercial troll fishery from areas within one nautical mile of the shore from June 21 to September 10, 2012.

#### 1.1.2.1.2 Northern British Columbia Sport Fishery Catch

Only the QCI sport catch is included in the AABM totals. Since 1995, catches in the QCI sport fisheries have been estimated by creel surveys, lodge logbook programs and independent observations by CDFO staff. Catch for this fishery in 2012 was 40,050 Chinook salmon.

### 1.1.2.2 *West Coast Vancouver Island AABM*

Under the 2009 PST Agreement, the WCVI AABM fishery includes the WCVI troll and the outside WCVI sport fishery (defined below). The total AABM landed catch in the commercial troll, outside tidal sport, and FN troll in 2012 was 134,468 Chinook salmon (Table 1.1.2).

#### 1.1.2.2.1 West Coast Vancouver Island Troll Fishery Catch

The AABM troll catch includes the commercial and FN troll caught Chinook salmon in Statistical Areas 21, 23–27, and 121–127. In the 2012 season (October 1, 2011 to September 30, 2012), WCVI troll fishing opportunities were consistent with a CDFO commitment to evaluate winter fisheries as a means to improve the economic base for the fleet and local communities while increasing flexibility in catch opportunities and reducing the catch rates on stocks encountered in summer fisheries (Table 1.1.2.2.1). Troll fishery openings were shaped by conservation concerns for Fraser River spring run age 1.2, Fraser River spring run age 1.3, Fraser River summer run age 1.3, WCVI, and Lower Strait of Georgia (LGS) Chinook salmon and interior Fraser River coho salmon.

*Table 1.1.2.2.1.–Fishing periods and Chinook salmon caught and released during the 2012 catch year in the West Coast Vancouver Island (WCVI) commercial troll fishery.*

| Fishing Period[1] | Areas Open | Main Area Fished | Landed Catch | Legal Releases | Sub-legal releases |
|---|---|---|---|---|---|
| Nov 15–Dec 31 | Areas; 23, 24, 25, 26, 27, 123, 124, 125, 126, 127 | 123/126 | 245 | 0 | 54 |
| Jan 1–31 | Areas; 23, 24, 25, 26, 27, 123, 124, 125, 126, 127 | 23/126 | 129 | 0 | 21 |
| Feb 1–29 | Areas; 23, 24, 25, 26, 27, 123, 124, 125, 126, 127 | 123/126 | 542 | 3 | 63 |
| March 1– 15 | Areas; 23, 24, 25, 26, 27, 125, 126, 127 | 23/126 | 243 | 0 | 10 |
| Apr 19–24 | Areas; 23, 24, 25, 26, 27, 125, 126, 127 | 126/127 | 10,493 | 5 | 200 |
| May 1– 6 | Areas; 23, 24, 25, 26, 27, 124, 125, 126, 127 | 126/127 | 10,924 | 3 | 252 |
| May 7 | Areas; 23, 24, 25, 26, 27, 123, 124, 125, 126, 127 | 123/126 | 491 | 1 | 30 |
| May 12–15 | Areas; 23, 24, 25, 26, 27, 123, 124, 125, 126, 127 | 126/127 | 10,919 | 9 | 465 |
| Aug 5 | Areas; 123, 124, 125, 126, 127 | 123 | 4,280 | 4 | 232 |
| Sep 4–8[2] | Area; 123 | 123 | 0 | 173 | 262 |
| Sep 15–30 | Areas; 123, 124, 125, 126, 127 |  | 17,264 | 0 | 0 |
| Oct 10–11 | Areas; 123, 124, 125, 126, 127 | 123/126 | 0 | 0 | 0 |
| Total |  |  | 55,530 | 198 | 1,589 |

[1] West Coast Vancouver Island troll fisheries were generally closed from mid-June to late August to avoid encounters of interior Fraser River and Thompson River coho and the WCVI Chinook salmon stock.

[2] DNA sampling of sublegal Chinook salmon by Area G.

To reduce impacts on Fraser and LGS Chinook salmon, Southwest Vancouver Island areas 123 and 124 were closed from March 1 to April 23. In addition, fisheries from April 19 to June 10 were managed to monthly effort quotas rather than catch quotas. To reduce impacts on interior coho, coho non-retention remained in effect for the spring/summer period, Fraser coho encounter rates were monitored, commercial fisheries were closed from mid-June through July, and plugs were used to avoid impacts on coho in August and early September fisheries. To reduce impacts on WCVI Chinook salmon, nearshore area closures were in effect from August through mid-September. To reduce impacts on LGS Chinook salmon, catch levels were reduced during the spring period when recent impacts were highest. This measure also provides some benefits to spring run U.S. Chinook salmon stocks when the mature run is abundant on the WCVI. Statistical Area 121 (Swiftsure Bank) remained closed in 2012. Selective fishing practices were mandatory, including single barbless hooks and "revival tanks" for resuscitating coho salmon prior to release. The minimum size limit for commercial troll for all periods was 55 cm (21.6 in) fork length.

From July 18 to September 30, 2012, the T'aaq-wiihak demonstration fishery, a new fishery in 2012, occurred in portions of Pacific Fishery Management Areas 24 and 124. The fishery eventually included portions of Pacific Fishery Management Area 125.

The catch for 2012 commercial troll fisheries was 55,530 Chinook salmon (Table 1.4). The WCVI FN caught an estimated 5,000 Chinook salmon in FSC fisheries, 2,232 Maanulth Treaty catch, and 6,292 in T'aaq-wiihak Demonstration fisheries 2012. Therefore, the total WCVI AABM troll catch for 2012 was 69,054 with 198 legal and 1,589 sublegal Chinook salmon releases (not including releases from the WCVI FN troll fisheries, which are currently unknown).

#### 1.1.2.2.2 West Coast Vancouver Island Sport Fishery Catch

The AABM sport fishery includes all catch in northwest WCVI (Areas 25–27, 125–127) from October 16 to June 30, and the catch outside of the surfline (about one nautical mile offshore) from July 1 to October 15, plus all the catch in southwest WCVI (Areas 21, 23, 24, 121, 123, and 124) from October 16 through July 31 and the catch outside one nautical mile offshore from August 1 to October 15. Catch inside the surf line and outside the AABM periods specified above is included in ISBM fishery catch.

The WCVI AABM sport fishery occurs primarily in the Barkley Sound, outer Clayoquot Sound, and Nootka Sound areas. The majority of fishing effort occurs from mid-July through August in NWVI and August through mid-September in the Southwest Vancouver Island. Creel surveys two Chinook salmon greater than 45 were conducted from early June to mid-September. The Chinook salmon daily bag limit was 45 cm (17.7 in). Barbless hooks were mandatory.

The 2012 WCVI AABM sport landed catch estimate during the creel period was 65,414 Chinook salmon (Table 1.1.2.2.2). Catch rates were determined from anglers interviewed from June 1 to September 15. No creel surveys occurred between October and May, when effort is relatively low.

*Table 1.1.2.2.2.–West Coast Vancouver Island AABM sport fishery catches of Chinook salmon by Pacific Fishery Management Areas (PFMA) in 2012 representing catch from June 1 to September 15.*

| PFMA | 21/121 | 23/123 | 24/124 | 25/125 | 26/126 | 27/127 | Total |
|---|---|---|---|---|---|---|---|
| Catch | 10,226 | 25,004 | 10,119 | 6,601 | 7,476 | 5,988 | 65,414 |

## 1.2 Estimates of Incidental Mortalities in AABM Fisheries

### 1.2.1 Southeast Alaska Fisheries

Estimates of encounters and IM in SEAK fisheries are shown for 2012 in Table 1.2.1 and in Appendix A for prior years. Estimates were converted from total IM into treaty IM by multiplying the total encounters by the ratio of treaty catch to landed catch for each respective fishery. The 2012 troll encounters were estimated from regressions of historical encounter estimates and troll effort. The regression predicts encounter estimates from troll effort using encounter estimates obtained from direct fishery observation programs conducted during a series of years. The CR and CNR sublegal regressions use a data series from 1998 to 2006, while the CNR legal regression uses a data series from 1985 to 1988 and 1998 to 2006 (CTC 2011). Sport fishery releases were computed from the number of Chinook salmon caught and released as recorded on the annual Statewide Catch Survey (mail-in survey) forms. Legal and sublegal CNR purse seine encounters were calculated using a modified catch per landing approach that uses the relationship between the yearly catch and the magnitudes of legal and sublegal CNR encounters for years where direct observational data are available (CTC 2011). For the gillnet fishery, drop-off mortality was estimated as a percentage of the LC using the regional-specific drop-off rate for SEAK (CTC 2004c). Encounter estimates are multiplied by the respective IM rate found in CTC (1997) to obtain estimates of IM. The estimated total in 2012 was 286,623 nominal Treaty fish, including 241,015 Treaty fish in the landed catch, and 45,608 incidental mortalities.

*Table 1.2.1.– Estimates of treaty and total (Includes total treaty, terminal exclusion, and hatchery add-on catch and estimates of incidental mortality) landed catch, incidental mortality (in nominal numbers of fish), and total mortality in SEAK AABM fishery, 2012.*

| SEAK Fishery | Landed Catch | Legal Encounters | Sublegal Encounters | Total LIM[2] | Total SIM[2] | Total IM | Total Mortality |
|---|---|---|---|---|---|---|---|
| Treaty | | | | | | | |
| Troll CR | 191,856 | 191,856 | 69,131 | 1,535 | 18,181 | 19,716 | 211,572 |
| Troll CNR | 0 | 26,406 | 17,488 | 5,783 | 4,599 | 10,382 | 10,382 |
| Troll Total | 191,856 | 218,262 | 86,618 | 7,318 | 22,781 | 30,098 | 221,954 |
| Sport Total[1] | 36,449 | 17,848 | 30,717 | 4,150 | 4,884 | 9,034 | 45,483 |
| Gillnet | 6,684 | 6,684 | 0 | 134 | 0 | 134 | 6,818 |
| Seine CR | 6,025 | 6,025 | 875 | 0 | 751 | 751 | 6,776 |
| Seine CNR | 0 | 2,271 | 6,032 | 1,158 | 4,433 | 5,592 | 5,592 |
| Net Total | 12,709 | 14,981 | 6,906 | 1,292 | 5,184 | 6,476 | 19,185 |
| Treaty Total | 241,015 | 251,090 | 124,241 | 12,760 | 32,848 | 45,608 | 286,623 |
| Total SEAK | | | | | | | |
| Troll CR | 209,392 | 209,392 | 75,449 | 1,675 | 19,843 | 21,518 | 230,910 |
| Troll CNR | 0 | 27,208 | 18,019 | 5,958 | 4,739 | 10,697 | 10,697 |

–continued–

*Table 1.2.1.– Page 2 of 2.*

| SEAK Fishery | Landed Catch | Legal Encounters | Sublegal Encounters | Total LIM[2] | Total SIM[2] | Total IM | Total Mortality |
|---|---|---|---|---|---|---|---|
| Troll Total | 209,392 | 236,600 | 93,468 | 7,634 | 24,582 | 32,216 | 241,608 |
| Sport Total[1] | 46,520 | 22,779 | 39,204 | 5,297 | 6,233 | 11,530 | 58,050 |
| Gillnet | 18,338 | 18,338 | 0 | 367 | 0 | 367 | 18,704 |
| Seine CR | 21,145 | 21,145 | 3,070 | 0 | 2,634 | 2,634 | 23,779 |
| Seine CNR | 0 | 7,971 | 21,168 | 4,065 | 15,558 | 19,624 | 19,624 |
| Net Total | 39,483 | 47,454 | 24,238 | 4,432 | 18,192 | 22,624 | 62,107 |
| SEAK Total | 295,395 | 306,832 | 156,909 | 17,362 | 49,008 | 66,370 | 361,765 |

[1] Catch data are preliminary estimates from creel survey expansions; IM for the SEAK sport fishery is estimated from the preliminary LC and the previous year IM to LC ratios. Final estimates are available from mail-out surveys in October one year post fishing season and will be reported in Appendix A.2 and A.3 of the next annual Catch and Escapement Report.

[2] Includes dropoff mortality. LIM=Legal Incident Mortality, SIM=Sublegal Incident Mortality.

## 1.2.2 British Columbia Fisheries

### 1.2.2.1 *Northern British Columbia Fisheries*

Table 1.2.2.2 summarizes estimates of landed catch, encounters and associated incidental mortalities by size class during CR and CNR fishing periods that occurred within the NBC AABM fishery in 2012. Releases for the NBC troll fishery are based on logbook data. Encounters from the QCI sport fishery are based on creel survey and logbook programs. IM estimates were derived using size specific rates from the CTC (1997). The estimated total mortality for 2012 was 131,782 nominal fish including 120,307 fish in the landed catch and 11,475 incidental mortalities.

### 1.2.2.2 *West Coast Vancouver Island Fisheries*

The estimated total mortality of Chinook salmon that occurred within the WCVI AABM fishery in 2012 was 150,858 nominal fish, including 134,468 Chinook salmon in the landed catch and 16,390 Chinook salmon from IM (Table 1.2.2.2). The estimated IM included 12,190 legal and 4,200 sublegal nominal Chinook salmon. Table 1.2.2.2 also summarizes encounters for these fisheries by size class during CR and CNR fisheries. In 2012, a non-retention AABM troll fishery opened in September to collect DNA samples from sublegal Chinook salmon.

*Table 1.2.2.2.–Estimates of treaty and total landed catch, incidental mortality (in nominal numbers of fish), and total mortality in NBC and WCVI AABM fisheries, 2012.*

| Fishery | Landed Catch | Legal Encounters | Sublegal Encounters | LIM Drop-off | Total LIM | Total SIM | Total IM | Total Mortality |
|---|---|---|---|---|---|---|---|---|
| **NBC** | | | | | | | | |
| Troll CR | 80,257 | - | 10,461 | 1,364 | 1,364 | 4,140 | 5,505 | 85,762 |
| Troll CNR | - | 3,901 | 518 | - | 788 | 205 | 993 | 993 |
| Troll Total | 80,257 | 3,901 | 10,979 | 1,364 | 2,152 | 4,345 | 6,498 | 86,755 |
| Sport Total | 40,050 | 22,235 | - | 1,442 | 4,977 | - | 4,977 | 45,027 |
| NBC Total | 120,307 | 26,136 | 10,979 | 2,806 | 7,130 | 4,345 | 11,475 | 131,782 |
| **WCVI** | | | | | | | | - |
| Troll CR | 55,530 | 25 | 1,327 | 944 | 949 | 525 | 1,474 | 57,004 |
| Troll CNR | - | 173 | 262 | - | 35 | 104 | 139 | 139 |
| FN Troll[1] | 13,524 | - | - | 230 | 230 | - | 230 | 13,754 |
| Troll Total | 69,054 | 198 | 1,589 | 1,174 | 1,214 | 629 | 1,843 | 70,897 |
| Sport Total | 65,414 | 33,661 | 18,598 | 4,514 | 10,976 | 3,571 | 14,547 | 79,961 |
| WCVI Total | 134,468 | 33,859 | 20,187 | 5,688 | 12,190 | 4,200 | 16,390 | 150,858 |

[1] FN troll includes FSC, Maanulth Treaty catch and T'aaq-wiihak catch.

## 1.3 Review of Individual Stock Based Management Fisheries

ISBM fisheries include all British Columbia Chinook salmon fisheries that are not included in the NBC and WCVI AABM fisheries, and all marine and freshwater Chinook salmon fisheries in Washington, Oregon, and Idaho. ISBM fisheries are managed with the intent of meeting management objectives for individual stocks listed in Attachments IV and V to Chapter 3, Annex IV to the PST.

### 1.3.1 Canadian Individual Stock Based Management Fisheries

The Canadian ISBM fisheries include all fisheries that catch or release Chinook salmon in British Columbia that are not AABM fisheries. In 2012, 189,820 Chinook salmon were caught in Canadian ISBM fisheries in British Columbia and Canadian sections of the transboundary Alsek, Taku and Stikine rivers. Total estimated IM in 2012 was 17,535 legal and 21,530 sublegal Chinook salmon. The distribution of the landed catches and estimated incidental mortalities are presented in Table 1.3.1.

*Table 1.3.1. –Landed catch and incidental mortalities in Canadian ISBM fisheries for 2012.*

| Region/Gear | Landed Catch | Release Legals | Release Sublegals | Total LIM | Total SIM | Total IM |
|---|---|---|---|---|---|---|
| Transboundary Rivers | 8,241 | 377 | 53 | 465 | 84 | 549 |
| Net | 7,407 | 10 | 53 | 350 | 84 | 434 |
| Freshwater Sport | 254 | 367 |  | 88 | - | 88 |
| FN-FSC | 580 |  |  | 27 | - | 27 |
| Northern British Columbia | 16,982 | 3,067 |  | 3,345 | - | 3,345 |
| Net | 780 | 3,067 |  | 2,661 | - | 2,661 |
| Tidal Sport | 7,017 |  |  | 253 | - | 253 |
| Freshwater Sport | 421 |  |  | 29 | - | 29 |
| FN-FSC | 8,189 |  |  | 377 | - | 377 |
| Tyee Test Fishery | 575 |  |  | 26 | - | 26 |
| Central British Columbia | 11,754 | 500 | - | 860 | - | 860 |
| Net | 3,624 | 500 | - | 533 | - | 533 |
| Tidal Sport | 5,861 |  |  | 211 | - | 211 |
| Freshwater Sport | 524 |  |  | 36 | - | 36 |
| FN-FSC | 1,745 |  |  | 80 | - | 80 |
| Troll |  |  |  | - | - | 0 |
| West Coast Vancouver Island | 45,804 | 3,291 | 10,277 | 3,682 | 1,973 | 5,655 |
| Net | 10,214 | 521 |  | 917 | - | 917 |
| Tidal Sport | 25,890 | 2,770 | 10,277 | 2,318 | 1,973 | 4,291 |
| Freshwater Sport | - | - | - | - | - | 0 |
| FN-EO | 9,700 |  |  | 446 | - | 446 |
| Johnstone Strait | 8,232 | 1,959 | 6,452 | 1,191 | 1,239 | 2,429 |
| Net | 37 | 468 |  | 346 | - | 346 |
| Tidal Sport | 7,874 | 1,447 | 6,452 | 821 | 1,239 | 2,060 |
| Freshwater Sport | - | - | - | - | - | 0 |
| FN-FSC | 321 |  |  | 15 | - | 15 |
| Troll | - | 44 |  | 9 | - | 9 |
| Georgia Strait | 25,553 | 2,010 | 43,775 | 2,078 | 8,405 | 10,483 |
| Net | - | - | - | - | - | 0 |
| Tidal Sport | 22,457 | 2,010 | 43,775 | 1,935 | 8,405 | 10,340 |
| Freshwater Sport | - | - | - | - | - | 0 |
| FN-FSC | 3,096 |  |  | 142 | - | 142 |
| Troll | - | - | - | - | - | 0 |
| Juan de Fuca | 22,438 | 3,366 | 8,361 | 2,306 | 2,111 | 4,417 |
| Net | 284 | 219 | 905 | 173 | 680 | 853 |
| Tidal Sport | 22,154 | 3,147 | 7,456 | 2,133 | 1,432 | 3,564 |
| FN-FSC |  |  |  | - | - | 0 |
| Fraser River | 50,816 | 5,868 | 2,037 | 3,805 | 744 | 4,549 |
| Commercial Net | - | - | - | - | - | 0 |
| FN-EO Net | 1,069 | - | 468 | 49 | 443 | 492 |
| FN-FSC Net | 36,521 | 104 | - | 1,778 | - | 1,778 |
| Mainstem Catch Sport | 5,204 | 378 | 119 | 432 | 23 | 455 |
| Test Fishery Net | 1,830 |  |  | 84 | - | 84 |
| Trib Catch Sport | 6,192 | 5,386 | 1,450 | 1,461 | 278 | 1,740 |
| **Grand Total** | **189,820** | **20,438** | **70,955** | **17,731** | **14,556** | **32,287** |

## 1.3.2 Southern U.S. Individual Stock Based Management Fisheries

Southern U.S. fisheries of interest to the PSC, generally those north of Cape Falcon, Oregon, are managed in accordance with legal obligations stemming from treaties between Indian tribes and the U.S., and where relevant, the conservation constraints set by the Endangered Species Act. In 1974, *U.S. v Washington* set forth sharing obligations to meet treaty fishing rights in western Washington. Treaty rights of Columbia River tribes were defined by *U.S. v Oregon*, and the Columbia River Fisheries Management Plan was implemented in 1977. In reporting these fisheries, fisheries are termed "treaty" if they are fishing under the Native American Treaty fishing rights and "non treaty" otherwise. As specified in the 2009 Agreement, all southern U.S. fisheries are ISBM fisheries. Historical catches in these fisheries are provided in Appendices A.16 through A.22.

### 1.3.2.1 *Strait of Juan de Fuca and the San Juan Islands*

The preliminary estimate of the 2012 Chinook salmon catch in Strait of Juan de Fuca tribal net fisheries was 1,525 fish with the majority of these taken during fisheries targeting Fraser River sockeye. There were 441 Chinook salmon harvested in the San Juan Islands net fisheries. The preliminary estimate of the 2012 Strait of Juan de Fuca treaty troll fishery catch (through December 2012) is 1,026 Chinook salmon. The catch estimate does not include catches from Area 4B during the May to September Pacific Fisheries Management Council management period. Historic catch estimates are provided for the Strait of Juan de Fuca (Appendix A.16) and San Juan areas (Appendix A.17).

### 1.3.2.2 *Puget Sound*

The preliminary estimate of the 2012 tribal and non-tribal net fishery harvests in Puget Sound marine areas is 79,387 (70,354 tribal, 9,033 non-tribal) for all marine areas excluding Strait of Juan de Fuca (Area 4B, 5, 6, 6A, 6B, and 6C) and San Juan Islands (Area 7 and 7A). Additional tribal net harvest occurred in freshwater fisheries with a preliminary estimate of 36,530. Estimates of the sport catch in 2012 are not yet available from the Washington Department of Fish and Wildlife (WDFW) Catch Record Card accounting system; thus, the preliminary estimate of sport catch reported here for 2012 is an average of the previous three years. Historic catch tables for Puget Sound exclusive of the Strait of Juan de Fuca and San Juan Islands are provided in Appendix A.18.

### 1.3.2.3 *Washington Coast Terminal*

Tribal commercial, ceremonial and subsistence fisheries harvested 13,429 Chinook salmon in north coastal rivers (Quinault, Queets, Hoh, and Quillayute) in 2012. An additional 33 Chinook salmon were harvested by the Makah tribal fisheries in the Waatch and Sooes rivers.

Harvest in Grays Harbor includes catch from both the Humptulips and Chehalis rivers. The 2012 tribal net fisheries harvested an estimated 3,988 Chinook salmon. The 2012 non-treaty commercial net harvest in Grays Harbor was 2,089 Chinook salmon. An estimated 9,726 Chinook salmon were harvested by non-treaty commercial net fisheries in Willapa Bay in 2012.

From Grays Harbor north, sport fisheries were implemented based upon pre-season tribal-state agreements and were subject to in-season adjustment. Estimates of sport fishery catches for Washington coastal terminal fishing areas in 2012 are not yet available from the Catch Record Card accounting system, but are approximated here based on the average catch from the previous three years. Historic catch estimates for Washington Coastal inside fisheries are shown in Appendix A.19.

#### 1.3.2.4 *North of Cape Falcon*

Ocean fisheries off the coasts of Washington, Oregon, and California are managed under regulations recommended by the Pacific Fishery Management Council. For 2012, the estimated catch of Chinook salmon in commercial troll fisheries from Cape Falcon, Oregon to the U.S.-Canada border was 99,792 for treaty and non-treaty fisheries combined. Estimated catch in the ocean sport fishery north of Cape Falcon in 2012 was 35,428 Chinook salmon. Historic catch estimates for U.S. ocean fisheries north of Cape Falcon are shown in Appendix A.20.

#### 1.3.2.5 *Columbia River*

Chinook salmon from the Columbia River are divided into eight stock groups for management purposes. These groups are delineated by run timing and area of origin: (1) spring run originating below Bonneville Dam, (2) spring run originating above Bonneville Dam, (3) summer run originating above Bonneville Dam, (4) fall run returning to Spring Creek Hatchery, (5) fall run originating in hatchery complexes below Bonneville Dam, (6) wild fall run originating below Bonneville Dam, (7) upriver bright fall run, and (8) Mid-Columbia bright fall hatchery fish.

For 2012, the preliminary estimate of total annual harvest for all fisheries (spring, summer and fall) in the Columbia River basin was 367,551 Chinook salmon, which included a non-treaty commercial net harvest of 76,292, a sport harvest of 122,411, a treaty Indian commercial, ceremonial and subsistence harvest of 168,825, and a Wanapum-Colville harvest of 23 Chinook salmon. Historic catch estimates for Columbia River fisheries are shown in Appendix A.21.

#### 1.3.2.6 *Oregon Coast Terminal*

Most harvest in ocean fisheries off Oregon's coast is comprised of a mixture of southern Chinook salmon stocks not included in the PSC agreement. These stocks do not migrate north into the PSC jurisdiction to any great extent. Chinook salmon of the NOC streams do migrate north and these populations are already included in the CTC Chinook model. Chinook salmon originating from Mid-Oregon Coastal (MOC) streams are also caught in PSC fisheries. The NOC stocks are harvested only incidentally in Oregon ocean fisheries, while the contribution of MOC stocks to Oregon ocean fisheries has historically been believed to be greater (based on CWT distribution data). MOC catch statistics are readily available only for one terminal ocean area troll fishery on a hatchery supplemented stock at the mouth of the Elk River. Late season (October to December) troll catch in the Elk River terminal troll fishery in 2012 was 636 Chinook salmon.

Sport catch of these two stock groups occurs primarily in estuary and freshwater areas as mature fish return to spawn and is reported through a punch card accounting system. These estimates become available more than two years after the current season. Therefore, in-river and estuary sport catch punch card estimates are provided through 2011 only for the NOC. The 2011 punch card estimate of estuary and freshwater catch for the NOC group is 33,089 Chinook salmon. However, catch projections have been made for 2012 using correlations between escapement and punch card catch estimates for past years; these preliminary estimates of terminal sport catch for 2012 are presented in Table 1.3.1. Historical catch estimates for the Elk River troll fishery and the estuary and freshwater sport fisheries targeting on MOC and NOC stocks are shown in Appendix A.22.

## 1.3.3 Estimates of Incidental Mortality for Southern U.S. Fisheries

Table 1.3.3 shows estimates of incidental mortalities for southern U.S. fisheries in marine and river fisheries in Puget Sound, on the Washington and Oregon coast north of Cape Falcon, Oregon coast terminal fisheries, and in the Columbia River fisheries. Incidental mortality was calculated using the release mortality, drop-out, and drop-off mortality rates assigned for areas and gears in CTC (1997). Number of fish released is from creel interviews, voluntary trip reports, on-water monitoring, or extrapolated from similarly structured fisheries with known release information data.

*Table 1.3.3.–Estimated incidental mortality in Southern U.S. troll, net, and sport fisheries, 2009–2012.*

| Fishery | Gear | 2012 | | | 2011 | | | 2010 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | LC | Releases | IM | LC | Releases | IM | LC | Releases | IM |
| **Juan de Fuca** | **Net** | 1,523 | NA | 122 | 352 | NA | 28 | 1,339 | NA | 107 |
| | **Sport** | 10,726[1] | 34,894[1] | 10,907[1] | 9,504 | 20,601 | 6,899 | 11,508 | 38,036 | 11,862 |
| | **Troll** | 1,026 | NA | 26 | 4,090 | NA | 102 | 2,011 | NA | 50 |
| ***Total*** | | **13,275** | **34,894** | **11,054** | **13,946** | **20,601** | **7,029** | **14,858** | **38,036** | **12,020** |
| **San Juans** | **Net** | 441 | 218 | 210 | 5,810 | 11,893 | 9,979 | 5,950 | 4,972 | 4,454 |
| | **Sport** | 4,476[1] | 4,793[1] | 1,934[1] | 6,193 | 6,603 | 2,668 | 3,157 | 2,402 | 1,102 |
| ***Total*** | | **4,917** | **5,011** | **2,144** | **12,003** | **18,496** | **12,647** | **9,107** | **7,374** | **5,555** |
| **Puget Sound** | **Net** | 115,917 | NA | 9,273 | 100,692 | NA | 8,055 | 72,576 | NA | 5,806 |
| | **Sport** | 31,993[1] | 66,031[1] | 22,335[1] | 29,829 | 78,760 | 25,433 | 32,817 | 43,512 | 16,420 |
| ***Total*** | | **147,910** | **66,031** | **31,608** | **130,521** | **78,760** | **33,488** | **105,393** | **43,512** | **22,226** |
| **Wash. Inside Coastal** | **Net** | 29,232 | NA | 585 | 39,034 | NA | 781 | 12,794 | NA | 256 |
| | **Sport** | 8,933[1] | NA | 616[1] | 13,340 | NA | 920 | 6,831 | NA | 471 |
| ***Total*** | | **38,165** | - | **1,201** | **52,374** | - | **1,701** | **19,625** | - | **727** |
| **Columbia River** | **Net** | 245,140 | 4,436 | 13,672 | 265,740 | 6,964 | 15,138 | 291,417 | 7,826 | 17,016 |
| | **Sport** | 122,411 | 28,719 | 13,960 | 149,907 | 27,161 | 15,558 | 162,707 | 24,187 | 15,871 |
| ***Total*** | | **367,551** | **33,155** | **27,633** | **415,647** | **34,125** | **30,696** | **454,124** | **32,013** | **32,886** |

–continued–

*Table 1.3.3.–Page 2 of 2.*

| Fishery | Gear | 2012 | | | 2011 | | | 2010 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | LC | Releases | IM | LC | Releases | IM | LC | Releases | IM |
| **Wa./Or. North Falcon** | **Sport** | 35,428 | 42,874 | 7,388 | 30,826 | 55,050 | 9,090 | 38,686 | 36,403 | 6,505 |
| | **Troll** | 99,792 | NA | 2,495 | 61,433 | NA | 1,536 | 88,565 | NA | 2,214 |
| ***Total*** | | **135,220** | **42,874** | **9,882** | **92,259** | **55,050** | **10,626** | **127,251** | **36,403** | **8,719** |
| **Oregon Inside** | **Sport** | 26,485[3] | NA | 1,827[3] | 33,089[3] | NA | 2,283[3] | 23,366 | NA | 1,612 |
| | **Troll**[4] | 636 | NA | 10 | 1,954 | NA | 31 | 1,315 | NA | 21 |
| ***Total*** | | 27,121 | NA | 1,837 | 27,493 | NA | 1,793 | 24,681 | NA | 1,633 |
| ***GRAND TOTAL*** | | **734,159** | **181,965** | **85,360** | **751,793** | **207,032** | **98,501** | **755,039** | **157,338** | **83,766** |

[1] WDFW Catch Record Card estimates of landed catch were not yet available; LC and releases for 2012 were computed using 2009–2011 mean values.

[2] The catch estimate is not yet available. Both landed catch and releases are based on the relationship between historical estimates of catches, escapements and releases. IM is imputed onto estimates of releases in accordance with mortality rates agreed to by the Pacific Fishery Management Council's Model Evaluation Workshop document Fishery Regulation Assessment Model (FRAM) An Overview for Coho and Chinook – v 3.0.

[3] Values for 2011 and 2012 landed catch and IM are estimates based on averages, not actual observed values. These will become available after the timeframe required for this report.

[4] The value represented by "troll" represents the concentrated fishery off of the mouth of the Elk River which is designed to specifically exploit returning Elk River Chinook.

## 1.4 Summary of 2012 Coastwide LC, IM, and TM in PSC Fisheries

Table 1.4 provides a coastwide summary of Chinook salmon catches and estimates of IM and TM in PSC fisheries for 2012. It should be noted, for some component fisheries, that current 2012 LC and IM are not yet available; the preliminary estimates of LC and IM will be updated in future reports as observed data become available.

The preliminary estimate of total LC of Chinook salmon for all PSC fisheries in 2012 is 1,474,149, of which 1,029,554 were taken in U.S. fisheries and 444,595 in Canadian fisheries (Table 1.4). Total estimated IM associated with this harvest was 211,881 Chinook salmon (13% of the TM) in nominal fish. The TM for all PSC fisheries in nominal fish was 1,686,030 Chinook salmon which is approximately 240,000 less than recorded for 2011 and is equivalent to 2010 PSC TM (Appendix A.25). Of the 1,686,030 total PSC TM estimated for 2012, 1,181,283 occurred in U.S. fisheries and 504,746 in Canadian fisheries. For U.S. fisheries, 71% of the LC and 69% of TM occurred in ISBM fisheries, whereas in Canada, 43% of the LC and 44% of TM occurred in ISBM fisheries. Data for calculating summary information contained in Table 1.4 for 2012 and previous years can be found in Appendix A.23, A.24, and A.25.

*Table 1.4.–Summary in nominal fish of preliminary estimates for landed catch (LC), incidental mortality (IM), and total mortality (TM) for U.S. and Canada AABM and ISBM fisheries in 2012.*

| | 2012 | | |
|---|---|---|---|
| **Fishery** | **LC** | **IM** | **TM** |
| SEAK AABM | 241,015 | 45,608 | 286,623 |
| SEAK hatchery add-on and terminal exclusion | 54,380 | 20,762 | 75,142 |
| U.S. ISBM | 734,159 | 85,360 | 819,519 |
| **U.S. TOTAL** | **1,029,554** | **151,729** | **1,181,283** |
| | | | |
| NBC AABM | 120,307 | 11,475 | 131,782 |
| WCVI AABM | 134,468 | 16,390 | 150,858 |
| CANADA ISBM | 189,820 | 32,287 | 222,107 |
| **CANADA TOTAL** | **438,944** | **60,151** | **504,746** |
| | | | |
| **PST FISHERIES TOTAL** | **1,474,149** | **211,881** | **1,686,030** |

# 2 CHINOOK SALMON ESCAPEMENTS

The Agreement established a Chinook salmon management program that

> *"introduces catch regimes that are based on estimates of Chinook salmon abundance, that are responsive to changes in Chinook salmon production, that take into account all fishery induced mortalities and that are designed to meet MSY or other agreed biologically-based escapement objectives"*

This chapter compares annual escapement estimates with MSY or other agreed biologically-based escapement goals established for Chinook salmon stocks. The CTC has reviewed and accepted escapement goals for 25 stocks included in this report.

This annual report, like those prior to 2006 (see CTC 2005) includes a section on the framework used for escapement assessments and narratives for each stock that includes a description of escapement methodology, escapement goal basis, and agency comments. Annual reports from 2006 to 2011 used an abbreviated narrative for each stock.

Escapement goals accepted by the CTC were based on analyses that followed the guidelines developed in the CTC escapement goal report (CTC 1999). In the stock-specific narratives presented with the escapement graphs, only CTC-accepted escapement goals and ranges (in gray shading) are shown on the escapement graphs and used for evaluation (Figures 2.2.1.1.1–2.2.3.4.5). Table 2.1.1 presents the status of escapement goal reviews by the CTC for stocks identified as escapement indicator stocks.

## 2.1 Escapement Goal Assessments

The Agreement (Annex IV, Chapter 3, Paragraph 1.b.iii) directs the CTC to

> *"report annually on the escapement of naturally spawning Chinook salmon stocks in relation to the agreed escapement objectives referred to below, evaluate trends in the status of stocks, and report on progress in the rebuilding of naturally spawning Chinook salmon stocks"*

In this report, escapement assessments include stock specific graphs of escapements and commentary, presented to provide a perspective on stock status and escapement trends through 2012.

The escapement goals and 2010 to 2012 escapements for the 25 stocks with CTC-accepted escapement goals are listed in Table 2.1.2. For 12 of these stocks, the agency escapement goal is defined as a range; for the remaining 13 stocks, the escapement goal is defined as a point estimate. In 2012, escapements were within the goal range for 5 stocks, above the range or $S_{MSY}$ point estimate for 13 stocks, and below the goal for 7 stocks.

The CTC has now assessed the status of stocks with CTC-accepted goals for return years 1999 to 2012. Over this time period, the number of stocks with CTC-accepted goals has increased from 15 to 25 (Figure 2.1). From 1999 to 2011, the percentage of stocks that met or exceeded escapement goals or goal ranges has varied from 50% to 96%. In 2012, the percentage of stocks that met or exceeded goal was 68%. Of the eight stocks below goal, three stocks (Chilkat, Andrew, and Chickamin) were within 15% of the target goal. Five stocks were more than 15% below goal: Situk, Unuk, Alsek, Harrison, and Cowichan.

*Table 2.1.1..–Pacific Salmon Commission Chinook salmon escapement indicator stocks.*

| Presence in Treaty Attachments | | | | | Stock Group In Att. I–V | Escapement Indicator | Region | Run |
|---|---|---|---|---|---|---|---|---|
| **SEAK** | **NBC/ QCI** | **WCVI** | **BC ISBM** | **SUS ISBM** | | | | |
| ✓ | | | | | | Situk | Yakutat | Spring |
| ✓ | | | | | | Chilkat | N. Inside | Spring |
| ✓ | | | | | | King Salmon | N. Inside | Spring |
| ✓ | | | | | | Andrew Creek | C. Inside | Spring |
| ✓ | | | | | | Unuk | S. Inside | Spring |
| ✓ | | | | | | Chickamin | S. Inside | Spring |
| ✓ | | | | | | Blossom | S. Inside | Spring |
| ✓ | | | | | | Keta | S. Inside | Spring |
| ✓ | | | | | | Alsek | TBR | Spring |
| ✓ | | | | | | Taku | TBR | Spring |
| ✓ | | | | | | Stikine | TBR | Spring |
| ✓ | ✓ | | ✓ | | North/Central British Columbia | Yakoun | NBC-Area 1 | Summer |
| ✓ | ✓ | | ✓ | | North/Central British Columbia | Nass | NBC-Area 3 | Spring/Summer |
| ✓ | ✓ | | ✓ | | North/Central British Columbia | Skeena | NBC-Area 4 | Spring/Summer |
| | | | ✓ | | North/Central British Columbia | Dean | CBC-Area 8 | Spring |
| | | | | | | Rivers Inlet | CBC-Area 9 | Spring/Summer |
| ✓ | ✓ | | ✓ | | WCVI Falls | Artlish, Burman, Kaouk, Tahsis, Tashish, Marble | WCVI | Fall |
| ✓ | ✓ | | ✓ | | UGS | Klinaklini, Kakwiekan, Wakeman, Kingcome, Nimpkish | UGS | Sum/Fall |
| | | | ✓ | | LGS | Cowichan/Nanaimo[2] | LGS | Fall |
| ✓ | ✓ | | ✓ | | Fraser Early[1] (Spr/Sum) | Fraser Spring 1.3 | FR | Spring |
| ✓ | ✓ | | ✓ | | Fraser Early[1] (Spr/Sum) | Fraser Spring 1.2 | FR | Spring |
| ✓ | ✓ | | ✓ | | Fraser Early[1] (Spr/Sum) | Fraser Summer 1.3 | FR | Summer |
| ✓ | ✓ | | ✓ | | Fraser Early[1] (Spr/Sum) | Fraser Summer 0.3 | FR | Summer |
| | | ✓ | ✓ | ✓ | Fraser Late | Harrison | FR | Fall |
| | | | ✓ | ✓ | North Puget Sound Natural Springs | Nooksack | NC/PS | Spring |
| | | | ✓ | ✓ | North Puget Sound Natural Springs | Skagit Spring | NC/PS | Spring |
| | | ✓ | ✓ | ✓ | Puget Sound Natural Summer/Falls | Skagit Summer/Fall | NC/PS | Summer/Fall |
| | | ✓ | ✓ | ✓ | Puget Sound Natural Summer/Falls | Stillaguamish | NC/PS | Summer/Fall |

–continued–

*Table 2.1.1.–Page 2 of 2.*

| Presence in Treaty Attachments | | | | | Stock Group In Att. I–V | Escapement Indicator | Region | Run |
|---|---|---|---|---|---|---|---|---|
| SEAK | NBC/ QCI | WCVI | BC ISBM | SUS ISBM | | | | |
| | | ✓ | ✓ | ✓ | Puget Sound Natural Summer/Falls | Snohomish | NC/PS | Summer/Fall |
| | | ✓ | ✓ | ✓ | Puget Sound Natural Summer/Falls | Lake Washington | NC/PS | Summer/Fall |
| | | ✓ | ✓ | ✓ | Puget Sound Natural Summer/Falls | Green | NC/PS | Summer/Fall |
| ✓ | ✓ | | | ✓ | Washington Coastal Fall Natural | Hoko | WAC/JDF | Fall |
| | | | | | | Quillayute Summer | WAC/JDF | Summer |
| ✓ | ✓ | | | ✓ | Washington Coastal Fall Natural | Quillayute Fall | WAC/JDF | Fall |
| | | | | | | Hoh Spring/Summer | WAC/JDF | Summer |
| ✓ | ✓ | | | ✓ | Washington Coastal Fall Natural | Hoh Fall | WAC/JDF | Fall |
| | | | | | | Queets Spring/Summer | WAC/JDF | Summer |
| ✓ | ✓ | | | ✓ | Washington Coastal Fall Natural | Queets Fall | WAC/JDF | Fall |
| | | | | | | Grays Harbor Spring | WAC/JDF | Spring |
| ✓ | ✓ | | | ✓ | Washington Coastal Fall Natural | Grays Harbor Fall | WAC/JDF | Fall |
| | | | | | | COLR Upriver Spring | COLR | Spring |
| ✓ | ✓ | ✓ | | ✓ | Columbia River Upriver Summers | Mid-COLR Summers | COLR | Summer |
| ✓ | ✓ | ✓ | | ✓ | Columbia River Falls | COLR Upriver bright | COLR | Fall |
| ✓ | ✓ | ✓ | | ✓ | Columbia River Falls | Lewis | COLR | Fall |
| ✓ | ✓ | ✓ | | ✓ | Columbia River Falls | Deschutes | COLR | Fall |
| ✓ | ✓ | | | ✓ | Far North Migrating Oregon Coastal | Nehalem | NOC | Fall |
| ✓ | ✓ | | | ✓ | Far North Migrating Oregon Coastal | Siletz | NOC | Fall |
| ✓ | ✓ | | | ✓ | Far North Migrating Oregon Coastal | Siuslaw | NOC | Fall |
| | | | | | | South Umpqua | MOC | Fall |
| | | | | | | Coquille | MOC | Fall |

*Note*: Refer to List of Acronyms for definitions.

*Note*: Shading indicates that there is not a CTC-accepted escapement goal.

[1] The escapement indicator stocks listed in the Annex tables for this group are Upper Fraser, Middle Fraser, and Thompson. The Fraser spring/summer group is split into these 4 escapement indicators to represent the stock group by life history type rather than geographically.

[2] An escapement goal was established for the Cowichan in 2005; a goal for Nanaimo is still pending.

*Table 2.1.2.–Escapement goals, 2010–2012 escapements, and 2013 forecasts for stocks with CTC-agreed goals.*

| Stock | Region | Stock Group | Escapement Goal | 2010 Escapement | 2011 Escapement | 2012 Escapement | 2013 Forecast |
|---|---|---|---|---|---|---|---|
| Situk | SEAK | Yakutat | 500–1,000 | **167**<br>**(33%)** | **240**<br>**(48%)** | **322**<br>**(64%)** | 475<br>(95%) |
| Chilkat | SEAK | Northern Inside | 1,750–3,500 | 1,815<br>(104%) | 2,688<br>(153%) | 1,627<br>(93%) | 2,022[1]<br>(115%) |
| King Salmon | SEAK | Northern Inside | 120–240 | 158<br>(132%) | 192<br>(160%) | 155<br>(129%) | NA |
| Andrew Creek | SEAK | Central Inside | 650–1,500 | 1,205<br>(185%) | 936<br>(144%) | 587<br>(90%) | NA |
| Unuk | SEAK | Southern Inside | 1,800–3,800 | 3,835<br>(213%) | 3,195<br>(178%) | **956**<br>**(53%)** | NA |
| Chickamin (survey index) | SEAK | Southern Inside | 450–900 | 1,156<br>(257%) | 852<br>(189%) | 444<br>(99%) | NA |
| Blossom | SEAK | Southern Inside | 565–1,160 | 1,405<br>(249%) | 569<br>(100%) | 793<br>(140%) | NA |
| Keta | SEAK | Southern Inside | 525–1,200 | 1,430<br>(273%) | 671<br>(128%) | 725<br>(138%) | NA |
| Alsek | SEAK/ TBR | TBR | 3,500–5,300 | 9,518<br>(272%) | 6,668<br>(191%) | **2,660**<br>**(76%)** | NA |
| Taku | SEAK/ TBR | TBR | 19,000–36,000 | 29,302<br>(154%) | 27,523<br>(145%) | 19,429<br>(102%) | 28,066[1]<br>(148%) |
| Stikine | SEAK/ TBR | TBR | 14,000–28,000 | 15,180<br>(108%) | 14,569<br>(104%) | 22,671<br>(162%) | 32,032[1]<br>(229%) |
| Harrison | BC | Fraser River | 75,100–98,500 | 103,515<br>(138%) | 123,647<br>(165%) | **44,467**<br>**(59%)** | **47,452**<br>**(63%)** |
| Cowichan | BC | LGS | 6,500 | **2,879**<br>**(44%)** | **3,492**<br>**(54%)** | **3508**<br>**(54%)** | NA |
| Columbia Upriver Summer | COLR | COLR | 12,143[3] | 47,228<br>(389%) | 44,432<br>(366%) | 52,184<br>(430%) | 50,715<br>(418%)[2] |
| Columbia Upriver brights | COLR | COLR | 40,000 | 167,007<br>(418%) | 130,395<br>(326%) | 131,613<br>(329%) | 164,350<br>(411%)[2] |
| Deschutes Fall | COLR | COLR | 4,532 | 9,275<br>(205%) | 17,117<br>(378%) | 17,624<br>(389%) | NA |
| Lewis | COLR | COLR | 5,700 | 8,701<br>(153%) | 8,009<br>(141%) | 8,143<br>(143%) | 10,650<br>(187%)[2] |
| Quillayute Fall | WAC | WAC | 3,000 | 4,635<br>(155%) | 3,993<br>(133%) | 3,181<br>(106%) | 5,815[1]<br>(194%) |
| Queets Spr/Sum | WAC | WAC | 700 | **382**<br>**(55%)** | **373**<br>**(53%)** | 764<br>(109%) | **357[1]**<br>**(51%)** |
| Queets Fall | WAC | WAC | 2,500 | 4,022<br>(161%) | 3,928<br>(157%) | 3,993<br>(160%) | 4,710[1]<br>(188%) |

–continued–

*Table 2.1.2.–Page 2 of 2.*

| Stock | Region | Stock Group | Escapement Goal | 2010 Escapement | 2011 Escapement | 2012 Escapement | 2013 Forecast |
|---|---|---|---|---|---|---|---|
| Hoh Spr/Sum | WAC | WAC | 900 | 828 (92%) | 827 (92%) | 915 (102%) | 851[1] (95%) |
| Hoh Fall | WAC | WAC | 1,200 | 2,599 (217%) | 1,293 (108%) | 1,937 (161%) | 3,095[1] (258%) |
| Nehalem | ORC | NOC | 6,989 | **5,384 (77%)** | 7,655 (109)% | 7,515 (108%) | 7,815 (112%) |
| Siletz | ORC | NOC | 2,944 | 4,225 (144%) | 3,638 (124%) | 4,871 (165%) | 5,764 (196%) |
| Siuslaw | ORC | NOC | 12,925 | 22,197 (172%) | 30,713 (238%) | 20,018 (155%) | 22,592 (175%) |

*Note:* Percentages relative to goals are in parentheses. Escapements below the goal or lower bound of the escapement range are shaded; escapements or forecasts below the 85% threshold applicable to Attachment I–III are bold.

[1] The forecast for Chilkat River Chinook salmon is an inriver run forecast and not a forecast of escapement; the forecasts for Taku and Stikine River Chinook salmon are terminal run forecasts and not forecasts of escapement; the inriver run forecasts for the Washington Coastals in 2013 are forecasts of escapement.

[2] The goal of 12,143 is based upon adults counted past Rock Island dam. The previously cited goal of 17,857 was obtained by expanding this Rock Island escapement goal for interdam losses between Bonneville and Rock Island dams, as documented in TCCHINOOK (99–3). These escapements and forecast presented are the sum of both hatchery and wild adults counted past Rock Island dam. Both escapement goals are documented by the CTC in TCCHINOOK (99–3).

[3] Projected escapement in 2013 based on 2010–2012 average escapement rate applied to 2013 terminal run forecast.

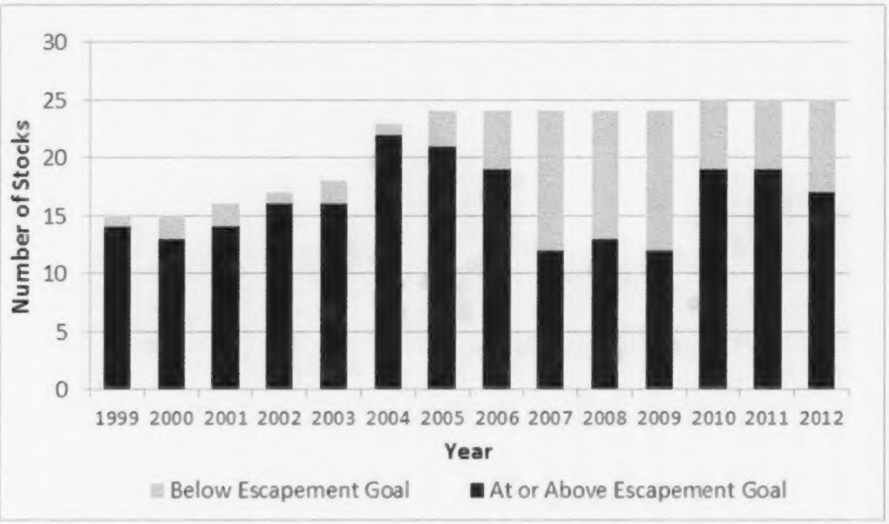


*Figure 2.1.–Number and status of stocks with CTC-accepted escapement goals, 1999–2012.*

## 2.2 Trends and Profiles for Escapement Indicator Stocks

Graphs of time series of escapements for Chinook salmon stocks are included in sections for Alaska, Canada, Puget Sound, Coastal Washington, Columbia River, and Oregon Coast. For each stock, there is a commentary describing the escapement methodology, escapement goal basis, escapement evaluation and agency comments. Escapement is usually reported in adults by calendar year (CY). All escapement goals accepted by the CTC are shown. Historical escapement and terminal run data are provided in the appendices for SEAK stocks (Appendix B.1), Canadian stocks (Appendix B.2, B.3, B.4, and B.5), Puget Sound (Appendix B.6), Washington Coastal stocks (Appendix B.7), Columbia River stocks (Appendix B.8) and Oregon Coastal stocks (Appendix B.9 and B.10).

### 2.2.1 Southeast Alaska and Transboundary River Stocks

Of the 11 SEAK and TBR stocks included in the escapement assessment, the Situk, Chilkat, Taku, King Salmon, Stikine, Unuk, Blossom, and Keta rivers and Andrew Creek include estimates of total escapement of large fish, Chinook salmon ≥ 660 mm mid eye to fork of tail length. In most systems these include ocean-age-3, -4, and -5 fish and include almost all females and large males in the stocks; ocean-age-1 and -2 males are not included in these estimates except those fish >659 mm mid eye to tail fork. Escapement estimates for the Chickamin River are index counts of large fish. These indices are enumerated from aerial helicopter surveys that represent a fraction (one-fifth) of the total number of large spawners. Except for the Chilkat River, survey methods have been standardized for all systems since 1975. The assessment of Chilkat River Chinook salmon was standardized in 1991 as an annual mark–recapture (MR) estimate of escapement. Escapement goals have been defined as a range for the SEAK/TBR stocks. Escapement estimates for the Alsek River are estimates of total escapement of age-1.2 fish and older.

The SEAK and TBR stocks can be classified into two broad categories, inside-rearing and outside-rearing, based on ocean migrations. Outside-rearing stocks have limited marine rearing in SEAK and are caught primarily during their return spawning migrations in the spring; these stocks include Chinook salmon returning to the Situk, Alsek, Taku, and Stikine rivers. Inside-rearing stocks are vulnerable to SEAK and NBC fisheries as immature fish as well as during their spawning migrations and include the other seven SEAK indicator stocks. Note that there is some overlap in these stocks within these two broad classifications. All SEAK and TBR indicator stocks produce primarily yearling smolt except the Situk River, which presently produces primarily sub-yearling smolt. Sub-yearling smolts comprise about 10% of the annual runs in the Keta and Blossom rivers.

A 15-year rebuilding program was established by the Alaska Department of Fish and Game ADF&G in 1981 (ADF&G 1981). At the same time, ADF&G established interim point escapement goals for all 11 systems, based on the highest observed escapement count prior to 1981. ADF&G and CDFO have subsequently revised escapement goals for the three TBR stocks which have been reviewed and accepted by the CTC. ADF&G has revised escapement goals for the other eight stocks that have been reviewed and accepted by the CTC, some more than once.

ADF&G uses escapement goal ranges in conformance with the ADF&G Salmon Escapement Goal Policy and Sustainable Salmon Fisheries Policy.

### 2.2.1.1 *Southeast Alaska Stocks*

#### 2.2.1.1.1 Situk River

The Situk River is a non-glacial system located near Yakutat, Alaska, that supports a moderate-sized, outside-rearing stock of Chinook salmon. Few Situk-origin Chinook salmon are caught in PSC fisheries other than in directed sport, commercial and subsistence fisheries located inriver, in the estuary, and in nearby surf waters. The fisheries that target this stock fall under a management plan directed to achieve escapements within the range.

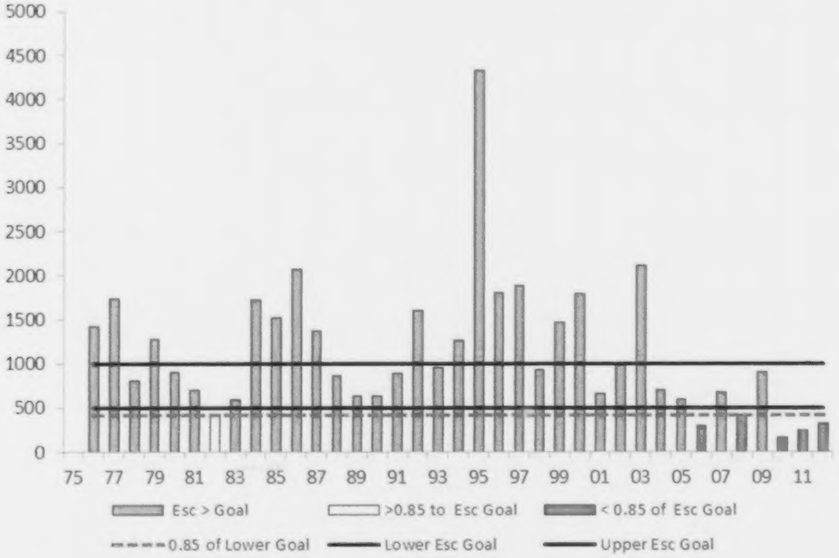


*Figure 2.2.1.1.1.–Situk River escapements of Chinook salmon, 1976–2012.*

**Escapement Methodology**: Escapements are based on weir counts minus upstream sport fishery harvests (if any), which are estimated from an on-site creel survey and a post-season mail-out survey. The weir has been operated annually since 1976, and was also operated from 1928 to 1955. Counts of large Chinook salmon are reported as the spawning stock. Jacks (ocean-age-1 and -2 fish) are also counted and, since 1989, jack counts (not included in the graph above) have ranged between 1,200 and 4,000 fish.

**Escapement Goal Basis**: In 1991, ADF&G revised the Situk River Chinook salmon escapement goal to 600 large spawners based upon a spawner–recruit analysis,[1] which was reviewed and adopted by the CTC. In 1997, ADF&G revised the Situk River escapement goal range to 500 to 1,000 large spawners to conform to the department's escapement goal policy. The CTC reviewed and accepted this change in 1998. ADF&G changed the goal range to 450 to 1,050 large spawners in 2003; this range was reviewed by the CTC in 2004 but not accepted.

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[1] Scott A. McPherson, ADF&G, to Keith Weiland, ADF&G. 1991 memorandum. Available from author, Douglas Island Center Building, 802 3$^{rd}$ Street, P. O. Box 240020, Douglas, AK 99824-0020.

**Escapement Evaluation**: Productivity of the Situk River stock has significantly declined over the last decade. Annual escapements less than 85% of the goal have occurred in five of the last seven years. The 2012 escapement was 322 fish, 64% of the lower end of the range, but the 2012 escapement was an improvement over the escapement levels observed in 2010 and 2011. There were no estimated harvests above the weir in 2012 and this is an exact count of escapement (Figure 2.2.1.1.1).

**Agency Comments**: Total annual terminal harvest rates (and all harvests within the PSC area) for all gear groups combined averaged about 60% from 1990 to 2003. Harvest rates have been substantially lower since 2004 because this stock has experienced poor natural survival for recent brood years. Terminal directed fisheries have been curtailed while incidental catches in sport and commercial fisheries have been restricted to non-retention of Chinook salmon since 2010.

### 2.2.1.1.2 Chilkat River

The Chilkat River is a moderate-sized glacial system located near Haines, Alaska which supports a moderate-sized, inside-rearing stock of Chinook salmon. Smolts from this stock have had CWTs applied at relatively high rates (8%–10%) beginning with the 1999 brood year; additional wild-stock tagging occurred for three broods prior to that time. Relatively small terminal U.S. marine sport and subsistence fisheries target this stock. This stock is also caught incidentally in sport, commercial drift gillnet and troll fisheries in northern SEAK.

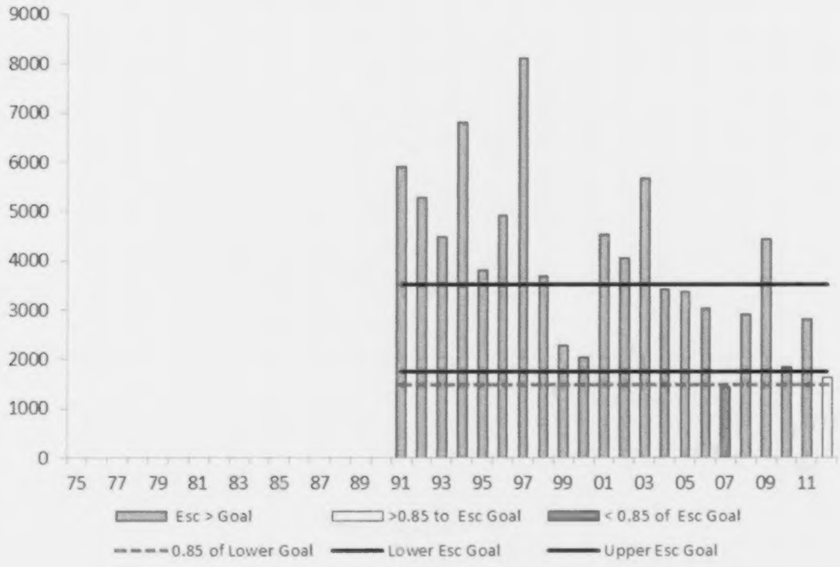


*Figure 2.2.1.1.2.–Chilkat River escapements of Chinook salmon, 1991–2012.*

**Escapement Methodology**: Escapements are based on estimates of large spawners from a MR program conducted annually since 1991 (Ericksen and McPherson 2003). The escapement data are relatively precise with CVs for annual escapements averaging 15% since 1991. From 1975 to 1992, aerial survey counts were conducted on two small tributaries with relatively clear water; results from these estimates were inconsistent. Radio telemetry studies conducted in 1991 and 1992 found that spawners in these two tributaries represented less than 5% of the total escapement, and did not represent trends in abundance and the aerial surveys were discontinued.

**Escapement Goal Basis**: The 1981 escapement goal was set at 2,000 large fish, based on an assumed fraction of the total escapement represented by discontinued survey counts. In 2003 Ericksen and McPherson (2003) recommended a revised escapement goal range of 1,750 to 3,500 large Chinook salmon spawners, based on the MR estimates of escapement and limited CWT information available for this stock. This goal range was reviewed and adopted by ADF&G and the Alaska Board of Fish in 2003 and subsequently reviewed and accepted by the CTC in 2004.

**Escapement Evaluation**: The Chilkat River stock is reasonably healthy with annual escapements of at least 85% of the goal in all years except in 2007. The 2012 escapement was 1,627 (CV = 0.16) Chinook salmon, 93% of the low end of the escapement goal range (Figure 2.2.1.1.2). This stock, like others in Alaska, has recently experienced a decline in productivity.

**Agency Comments**: Available CWT information on this stock suggests that exploitation is about 20% for recent brood years from the CTC exploitation rate analysis. Escapements since 1991 have been within or above the escapement goal range in all years except 2007 and 2012.

#### 2.2.1.1.3 King Salmon River

The King Salmon River is a small non-glacial system located on Admiralty Island southeast of Juneau that supports a small, inside-rearing stock. Few Chinook salmon originating in the King Salmon River are caught in PSC fisheries and there is no terminal fishery targeting this stock. However, harvests of immature and mature fish do occur in SEAK fisheries.

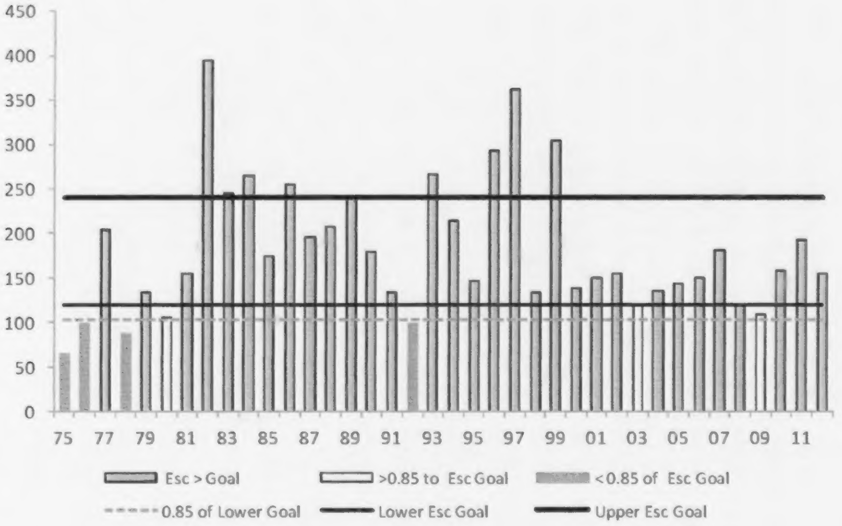


*Figure 2.2.1.1.3.–King Salmon River escapements of Chinook salmon, 1975–2012.*

**Escapement Methodology**: Escapements of large Chinook salmon are based upon weir counts from 1983 to 1992 and expansions of survey counts from 1971 to 1982 and 1993 to 2011, to make estimates equivalent to weir counts. A weir was operated for 10 years (1983–1992) along with the surveys and, on average the total escapement was 1.52 times the survey count (McPherson and Clark 2001). Jacks (ocean-age-2 fish) represented an average of 22% of the weir counts from 1983 to 1992 and are not included in the graph above.

**Escapement Goal Basis**: In 1981, ADF&G set the index goal at 200 large fish based upon peak survey counts of 200 spawners in 1957 and 211 spawners in 1973. In 1997, ADF&G revised the goal to 120 to 240 total large fish based upon a spawner–recruit analysis for the 1971 to 1991 brood years (McPherson and Clark 2001). The analysis and goal range was accepted by the CTC in 1998.

**Escapement Evaluation**: The King Salmon River stock is reasonably healthy with annual escapements of less than 85% of the goal only four times since 1976; three of those instances occurred in the mid- to late 1970s and the other was in 1992. The 2012 escapement was 155 (CV = 0.17) fish, within the goal range (Figure 2.2.1.1.3).

**Agency Comments**: There is no terminal fishery targeting this stock and escapements have been within or above the accepted range in most recent years.

### 2.2.1.1.4 Andrew Creek

Andrew Creek, near Petersburg, Alaska, is a small non-glacial U. S. tributary of the Lower Stikine River that supports a moderate run of inside-rearing Chinook salmon. Before 1976, a large terminal marine gillnet fishery occurred in the spring, targeting Stikine River and other nearby Chinook salmon stocks. Harvests of immature and mature Andrew Creek fish occur primarily in

SEAK and to a small extent in NBC fisheries, based on CWT recoveries of Chinook salmon from SEAK hatcheries using Andrew Creek brood stock.

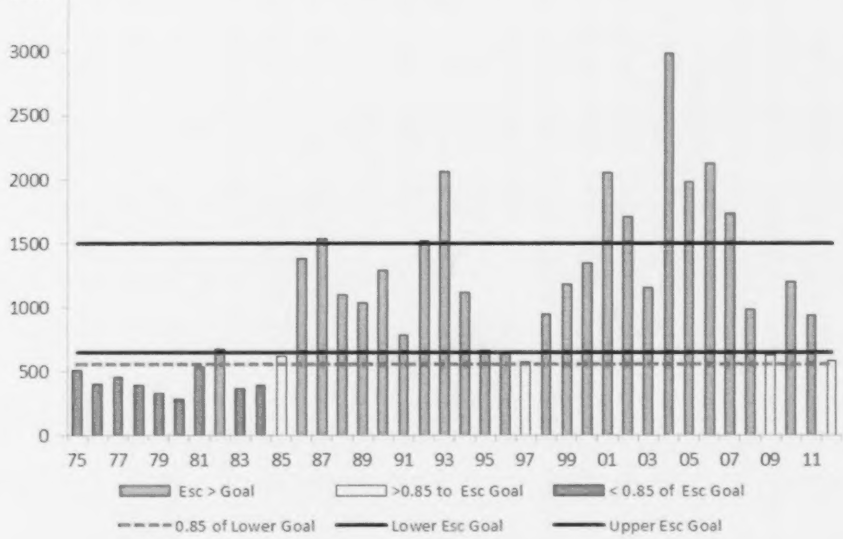


*Figure 2.2.1.1.4.–Andrew Creek escapements of Chinook salmon, 1975–2012.*

**Escapement Methodology**: Escapements are based upon weir counts from 1976 to 1984 and expansions of index counts in 1975 and from 1985 to 2011. Four years of concurrent weir and index count data were used to estimate the expansion factor of 1.95. Jacks have represented an average of 19% of the weir counts and are excluded in the figure above.

**Escapement Goal Basis**: In the early 1980s, ADF&G set the Andrew Creek Chinook salmon escapement goal at 750 large fish (total escapement). In 1997, an initial stock-recruit analysis was developed that underwent review by ADF&G and the CTC. This analysis was completed in 1998 and the technical report (Clark et al. 1998) recommended a revised biological escapement goal range of 650 to 1,500 large Chinook salmon that was accepted and adopted by the ADF&G and the CTC.

**Escapement Evaluation**: The Andrew Creek stock remains reasonably healthy, however, productivity has declined in recent years as has occurred with the Stikine origin Chinook salmon that spawn in Canada and has occurred with other Alaskan stock. Annual escapements of less than 85% of the goal have occurred nine times since 1975; however, all of those instances occurred prior to 1985. The 2012 escapement was 587 (CV = 0.23) fish, 90% of the lower end of the goal (Figure 2.2.1.1.4).

**Agency Comments**: Before 1976 a large terminal marine gillnet fishery occurred in the spring, targeting Stikine River and other nearby Chinook salmon stocks. Starting in 2005, during years of surplus production to the Stikine River, directed Chinook salmon fisheries were allowed in the marine waters in District 108 near Petersburg and Wrangell. Directed fisheries were allowed between 2005 and 2009. Very limited directed fishing for Stikine origin Chinook salmon occurred in 2011 and 2012. The implementation of the new directed fisheries has resulted in increased harvest rates of Andrew Creek Chinook salmon. Nevertheless, escapements since 2005 have been within or above the escapement goal range each year with the exception of 2009 and 2012, when escapements were below the range but more than 85% of the lower range.

#### 2.2.1.1.5 Unuk River

The Unuk River is a moderate-sized glacial system that supports a moderate run of inside-rearing Chinook salmon. Escapements are estimates of total escapement of large spawners. Harvests of immature and mature fish occur in SEAK and NBC fisheries. On average, for the 1992 to 2001 broods, harvest by gear sector was 47% SEAK troll, 36% SEAK sport, 10% SEAK net and most of the remainder caught in NBC. About 55% of the harvest is taken in the southern inside area of SEAK (mostly troll and sport). Estimated annual harvest rates averaged about 27% in nominal numbers and 24% in adult equivalents from 1985 to 1998 (Hendrich et al. 2008). Coded wire tagging of this stock was conducted for the 1982 to 1986 (Pahlke 1995) and the 1992 to present broods; this stock is now an exploitation rate indicator stock.

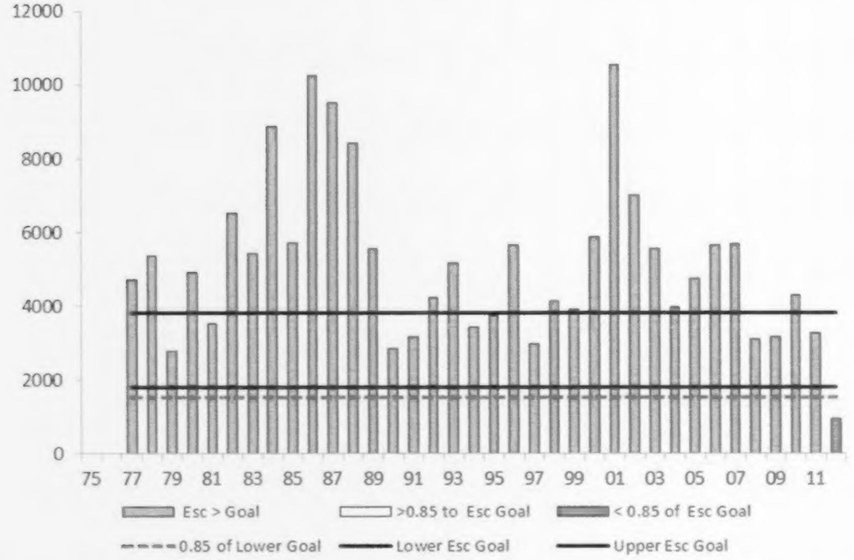


*Figure 2.2.1.1.5.–Unuk River escapements of Chinook salmon, 1977–2012.*

**Escapement Methodology**: Escapements of large spawners are MR estimates of total escapement from 1997 to 2011 and expanded survey counts from 1977 to 1996. Radio telemetry studies in 1994 and 2007 showed that the surveys are conducted in stream reaches where 80% of the spawning occurs; the expansion factor for survey counts is 4.83 (Hendrich et al. 2008).

**Escapement Goal Basis**: In 1994, ADF&G revised the Unuk escapement goal to 875 large spawners in survey (index) counts, based upon the spawner–recruit analysis reported by McPherson and Carlile (1997), which the CTC reviewed and accepted in 1994. In 1997, ADF&G revised the goal to a range of 650 to 1,400 large index spawners as recommended in the McPherson and Carlile (1997) report and in compliance with the ADF&G Escapement Goal Policy. The CTC reviewed and accepted this change in 1998. Since the expansion factor for surveys was unknown at that time, the goal was expressed in survey count currency. In 2008, a more extensive analysis was done with spawners, recruitment and fishing mortality expressed in total numbers of fish because of the extensive number of MR estimates of escapement and CWT data available (Hendrich et al. 2008). The analysis included the 1982 to 2001 brood years. The CTC-accepted a range of 1,800 to 3,800 large spawners, with a point estimate of 2,764 in 2009.

**Escapement Evaluation**: The Unuk River stock has demonstrated a healthy status with annual escapements from 1977 to 2011 within or above the escapement goal range in all years. However, productivity of the stock has declined in recent years and the 2012 escapement was only 956 (CV = 0.16) large Chinook salmon, 53% of the lower end of the goal range (Figure 2.2.1.1.5).

**Agency Comments**: The recent reduction in productivity of Chinook salmon stocks in Alaska has been recognized and ADF&G as the management agency is being challenged to respond to reduced run strength in many parts of the State. The large reduction in run strength of the Unuk stock in 2012 was unexpected, given its past history. There are no directed fisheries that target this stock, fishing in the Unuk River itself is banned, and nearby marine waters are closed to commercial fishing. Identification of additional management measures to take will be difficult.

#### 2.2.1.1.6 Chickamin River

The Chickamin River is a moderate-sized glacial system that supports a moderate run of inside-rearing Chinook salmon, based on wild stock CWTs. There is no terminal fishery targeting this stock; harvests of immature and mature fish occur in marine SEAK and NBC fisheries, with the majority of harvests taken in the southern inside quadrant of SEAK by troll and sport gear sectors. There is no subsistence or freshwater fisheries on any Behm Canal Chinook salmon stocks. Coded wire tagging on the Chickamin River was conducted for the 1982 to 1986 broods (Pahlke 1995) and resumed for the 2000 to 2006 broods. Total exploitation rates for recent broods were about 28% to 30% in adult equivalents under the current management regime.

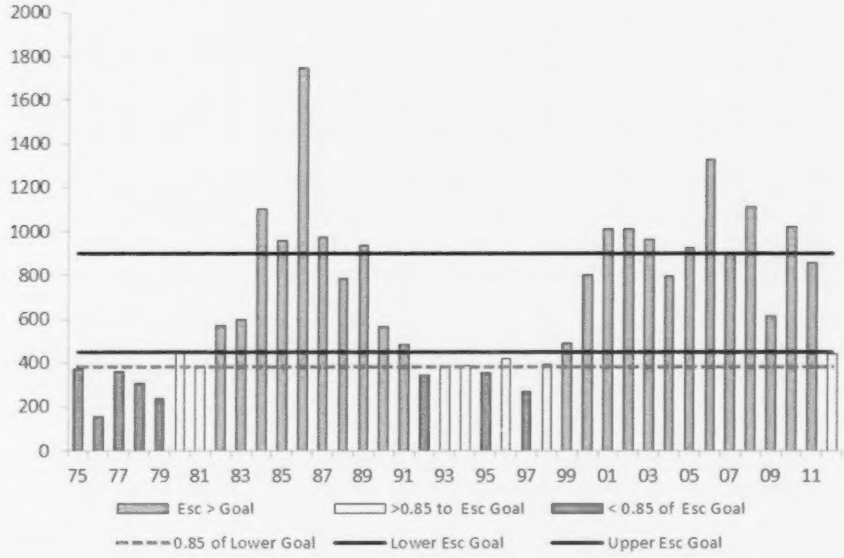


*Figure 2.2.1.1.6.–Chickamin River peak index counts of Chinook salmon, 1975–2012.*

**Escapement Methodology**: The escapements shown in Figure 2.2.1.1.6 are survey counts (unexpanded highest single-day counts) of large fish in eight tributaries of the Chickamin River using standardized methodology (Pahlke 2003). MR studies in 1995, 1996 and 2001 to 2005 found that about 21% of the total escapement is counted during peak surveys on average (Weller et al. 2007). A radio telemetry study in 1996 indicated that the annual surveys are conducted in stream reaches where over 80% of all spawning occurs. The expansion factor is estimated at 4.75 for survey counts using the results from the 1996 and 2001 to 2005 studies.

**Escapement Goal Basis**: In 1994, ADF&G revised the goal to 525 large index spawners based upon a spawner–recruit analysis (McPherson and Carlile 1997), which the CTC reviewed and accepted. In 1997, ADF&G revised the goal to 450 to 900 large index spawners as recommended in the McPherson and Carlile (1997) report and in compliance with the ADF&G Escapement Goal Policy (5 AAC 39.223). The CTC reviewed and accepted this change in 1998.

**Escapement Evaluation**: The Chickamin River stock is reasonably healthy while showing a cyclic pattern of escapement since 1975. Annual escapements less than 85% of the goal have occurred eight times since 1975, all of which occurred before 1998. The 2012 escapement index was 444 large spawning Chinook salmon, 99% of the lower end of the goal range. This index count is not expanded to an estimate of total escapement and has no associated variance, accordingly (Figure 2.2.1.1.6).

**Agency Comments**: Like the nearby Blossom and Keta rivers, this stock produces the largest Chinook salmon in SEAK. The time series of survey counts follows two cycles: counts from 1975 to 1981 and 1992 to 1998 were below the goal range, and those from 1982 to 1991 and 1999 to 2011 were all within or slightly above the range. The reduced 2012 escapement for this stock probably indicates reduced productivity as has been observed with many other Chinook salmon stocks in Alaska. If the cyclic pattern as observed in the past is recurring, future escapements will likely be low, even in the absence of fishing.

### 2.2.1.1.7 Blossom River

The Blossom River is a small-sized non-glacial system that supports a small run of inside-rearing Chinook salmon and empties into Behm Canal near Ketchikan. There is no terminal fishery targeting this stock; harvests of immature and mature fish occur in SEAK and NBC fisheries, based on wild stock and hatchery stock data from the nearby Unuk and Chickamin River. All waters of east Behm Canal are closed to Chinook salmon fishing year round. Age data collected since 1998 indicate that about 10% of the annual run had under-yearling smolt life history.

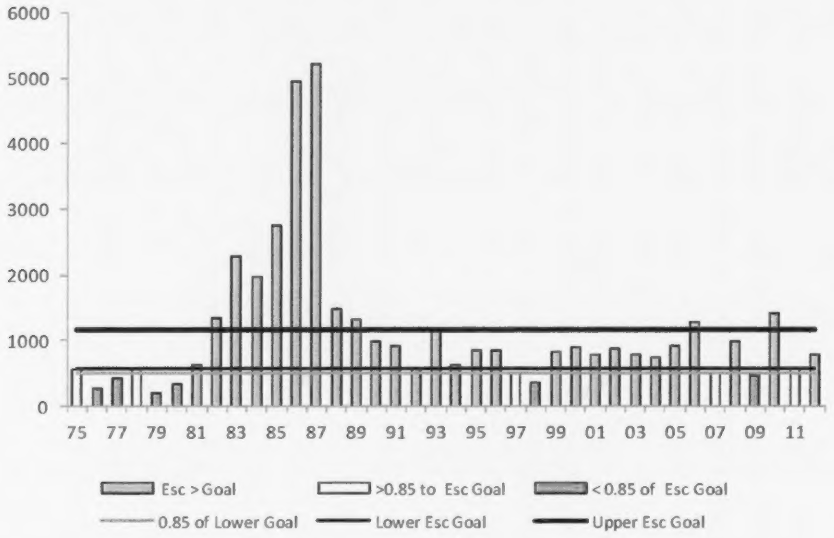


*Figure 2.2.1.1.7.–Blossom River escapements of Chinook salmon, 1975–2012.*

**Escapement Methodology**: Escapements are based upon MR experiments in 1998, 2004 to 2006 and expansions of index counts in all other years since 1975. Four years of concurrent MR and index count data were used to estimate the expansion factor of 3.87. Escapement estimates are expanded peak single-day survey counts of large spawners that have been standardized in area and time since 1975 (Pahlke 2003).

**Escapement Goal Basis**: In 1994, ADF&G revised the Blossom River goal to 300 large index spawners based upon a spawner–recruit analysis (McPherson and Carlile 1997), which the CTC reviewed and accepted. In 1997, ADF&G revised the goal to a range of 250 to 500 large index spawners in conformance with the McPherson and Carlile (1997) report and in compliance with the ADF&G Escapement Goal Policy. The CTC reviewed and accepted this change in 1998. In 2010, the ADF&G submitted a report to the CTC with a revised goal of 580 to 1,160 large spawners (Fleischman et al. 2011). The CTC accepted the revision in June 2011.

**Escapement Evaluation**: The Blossom River stock is reasonably healthy with annual escapements of less than 85% of the goal only six times since 1975. The 2012 escapement was 793 (CV = 0.62) large spawning Chinook salmon, a level within the goal range (Figure 2.2.1.1.7).

**Agency Comments**: Between 1976 and 1980, escapements were below the current escapement goal in four out of five years, averaging 361 large fish. These smaller escapements subsequently produced large runs with resultant large escapements during the six-year period from 1982 to 1987, averaging about 3,000 large fish. This six-year period of larger escapements has been followed by a 24-year period (1988–2011) of reduced, but relatively stable, escapements averaging about 850 large fish.

### 2.2.1.1.8 Keta River

The Keta River is a small-sized non-glacial system southeast of Ketchikan that supports a small run of inside-rearing Chinook salmon. There is no terminal fishery targeting this stock; harvests of immature and mature fish occur in SEAK and NBC fisheries, based on wild-stock and hatchery-stock data from the nearby Unuk and Chickamin River. All waters of east Behm Canal are closed to Chinook salmon fishing year round. Age data collected since 1998 indicate that about 10% of the annual run had under-yearling smolt life history.

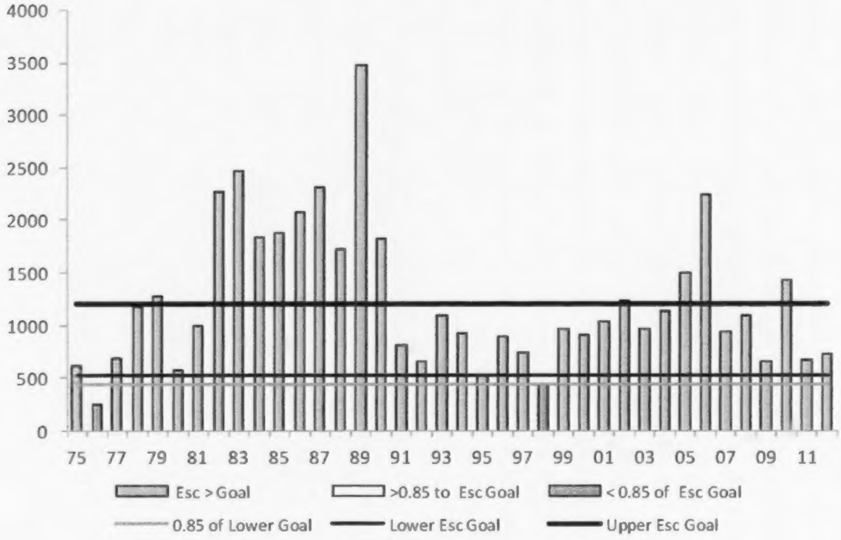


*Figure 2.2.1.1.8.–Keta River escapements of Chinook salmon, 1975–2012.*

**Escapement Methodology**: Escapements are based upon MR experiments in 1998 to 2000 and expansions of index counts in all other years since 1975 (Freeman et al. 2001). Three years of concurrent MR and index count data were used to estimate the expansion factor of 3.01. Escapement estimates are expanded peak single-day survey counts of large spawners that have been standardized in area and time since 1975 (Pahlke 2003).

**Escapement Goal Basis**: In 1994, ADF&G revised the escapement goal to 300 large index spawners based upon a spawner–recruit analysis (McPherson and Carlile 1997), which the CTC reviewed and accepted in 1994. In 1997, ADF&G revised the escapement goal to a range of 250 to 500 large index spawners in conformance with the McPherson and Carlile (1997) report and in compliance with the ADF&G Escapement Goal Policy (5 AAC 39.223). The CTC reviewed and accepted this change in 1998. In 2010, ADF&G submitted a report to the CTC with a revised goal of 525 to 1,200 large spawners (Fleischman et al. 2011). The CTC accepted the revision in June 2011.

**Escapement Evaluation**: The Keta River stock is reasonably healthy, with annual escapements of less than 85% of the goal only one time since 1975. The 2012 escapement was 725 (CV = 0.56) large spawning Chinook salmon, a level again within the goal range (Figure 2.2.1.1.8).

**Agency Comments**: Like the nearby Blossom River, survey counts were low in the 1970s, rose in the mid to late 1980s and have been relatively stable since that time. Between 1975 and 1981, annual escapements averaged about 800 large spawners. Production from the 1975 to 1981 escapements was high and from 1982 to 1990 averaged about 2,200 large fish. This was followed by a 21-year period (1991–2012) of relatively stable escapements, averaging about 1,000 large spawners. The recent reduction in productivity observed for many Alaskan stocks of Chinook salmon has not been noticeable with either the Blossom or Keta stocks of Chinook salmon to date.

### 2.2.1.2 *Transboundary River Stocks*

#### 2.2.1.2.1 Alsek River

The Alsek River is large transboundary glacial system that originates in the SW Yukon Territory and NW British Columbia and flows into the Gulf of Alaska about 50 miles east of Yakutat. This river supports a moderate run of outside-rearing Chinook salmon.

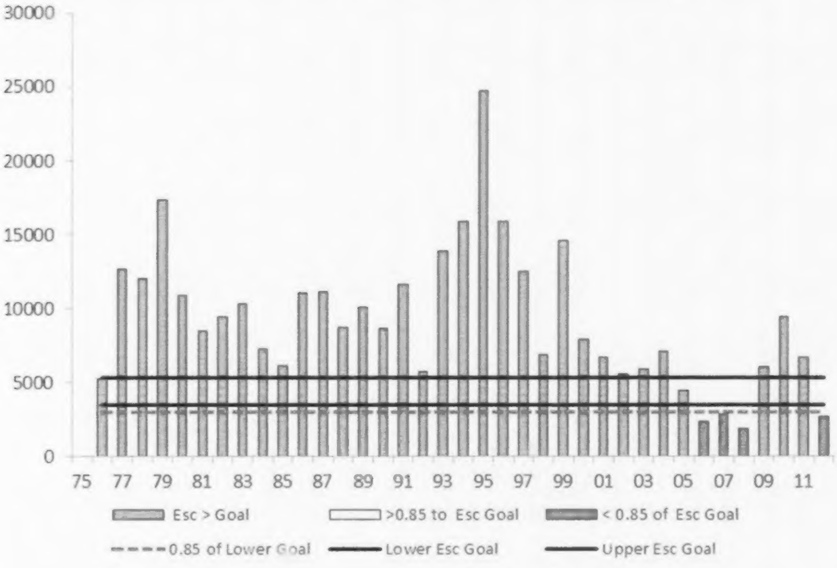


*Figure 2.2.1.2.1.–Alsek River escapements of Chinook salmon, 1976–2012.*

**Escapement Methodology**: Since 1976, escapements have been principally monitored by a weir operated at the Klukshu River, one of 51 tributaries of the Tatshenshini River, the principal salmon-producing branch of the Alsek River. Index escapements were estimated using a weir at the Klukshu River. These have been replaced with estimates of total escapement, drainage-wide, including direct MR estimates for years 1998 to 2004. All other years are Klukshu River weir counts expanded by the average expansion factor (4.00) from 1998 to 2004.

**Escapement Goal Basis**: A revised goal of 3,500 to 5,300 total spawners (fish age-1.2 and older) was accepted by the CTC, ADF&G, and Canadian Science Advisory Pacific, based on analysis in Bernard and Jones (2010). Prior to this, the goal was based on the escapement counted through the Klukshu River weir (McPherson et al. 1998).

**Escapement Evaluation**: Annual escapements of less than 85% of the goal have occurred four times since 1976, and all have been recent. These poor escapements appear to be the result of reduced productivity that has occurred in most of the last eight years because known harvest rates exerted on the stock are very small. Were none of the known harvest to have occurred in 2006, 2007, 2008, and 2012, the stock would have still failed to achieve the goal range. The 2012 escapement was only 2,660 (CV = 0.35) large Chinook salmon, 76% of the lower end of the goal range (Figure 2.2.1.2.1).

**Agency Comments**: Directed Canadian sport and aboriginal fisheries occur in various upriver sections of the Alsek River. Some Chinook salmon are caught as bycatch in the U.S. sockeye directed fishery that takes place in-river near the estuary and within the estuary. A few Chinook salmon are also caught in a U.S. subsistence fishery that takes place in the same area as the U.S. sockeye fishery. Total annual harvest rates have averaged 12% since 1976 (Bernard and Jones 2010).

#### 2.2.1.2.2 Taku River

The Taku River is a large Transboundary glacial system that supports a large run of outside-rearing Chinook salmon. Few Taku origin Chinook salmon are caught in PSC fisheries other than in terminal areas including District 11 of Southeast Alaska and in the Canadian portion of the lower river itself. Directed gillnet fisheries by both Parties to the Agreement take place in terminal areas in years when abundance exceeds predetermined levels as described in the Agreement under Chapter One, Transboundary Rivers 3(b)(3). In other years, Taku origin Chinook salmon are caught as bycatch in directed gillnet fisheries for sockeye salmon in terminal waters (District 11 of Southeast Alaska and in-river in Canada), in sport fisheries near Juneau Alaska, and in in-river First Nation fisheries in Canada.

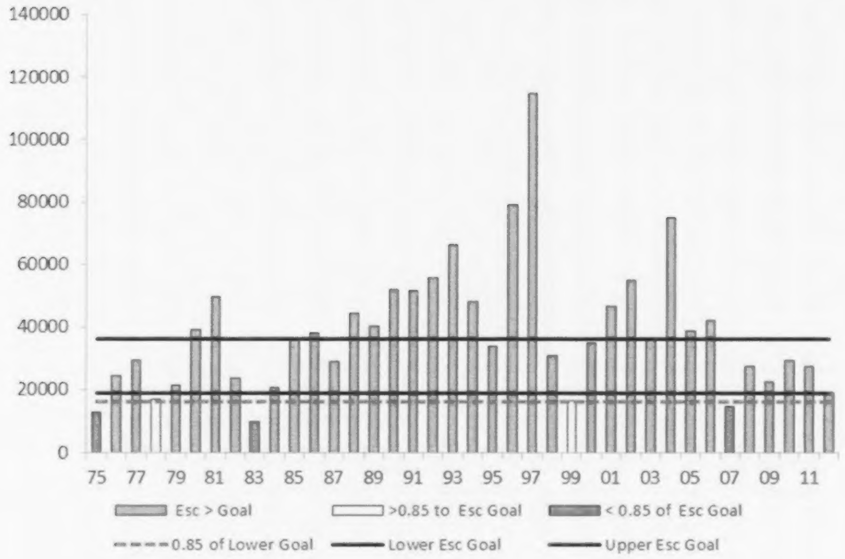


*Figure 2.2.1.2.2.–Taku River escapements of Chinook salmon, 1975–2012.*

**Escapement Methodology**: Total escapements of large fish (>659 mm mid eye to tail fork length) were estimated with MR experiments in 1989, 1990, and 1995 to the present. The MR estimates are unbiased and have an average CV of 15%. Aerial survey counts in other years were expanded by a factor of 5.2, which is the average of the ratio of the MR estimates to aerial survey counts. Aerial survey methods for stock assessment were standardized in 1975. Estimates of escapement based upon expanded aerial survey counts are assumed unbiased and have a CV of about 25%.

**Escapement Goal Basis**: Prior to 1999, several system-wide or index goals were developed by the U.S. and Canada based upon limited data. A goal based upon maximizing smolt production was in place from 1999 to 2009 (McPherson et al. 2000). In 2009, an escapement goal of 19,000 to 36,000 large Chinook salmon based upon stock-recruit analysis (McPherson et al. 2010) was accepted by the CTC.

**Escapement Evaluation**: The Taku River stock is reasonably healthy with annual escapements of less than 85% of the goal only three times since 1975 (1975, 1983, and 2007). Exploitation rates on the stock have never exceeded the MSY exploitation rate level. The 2012 escapement was estimated to be 19,429 (CV = 0.12) large Chinook salmon, just barely in excess of the goal range (Figure 2.2.1.2.2).

**Agency Comments**: The Taku River is both an escapement indicator stock and an exploitation rate indicator stock. Wild smolts have been marked with CWTs (1976–1981 and 1993–present), and CWT recoveries from fisheries and escapements are used to estimate exploitation rates and production. Historically, a significant terminal marine gillnet fishery occurred, but stock assessment was not adequate for management. In 2005, the Parties developed an abundance-based management regime for Taku River origin Chinook salmon with harvest sharing. The abundance-based management regime includes pre-season forecasts, in-season run projections, and post-season assessments which when coupled with carefully controlled weekly openings of gillnet fisheries on both sides of the border has allowed sustained harvest while ensuring escapement needs are not jeopardized by fishing. The Taku River stock of Chinook salmon has demonstrated declining productivity over the past few years, the issue appears to be reduced marine survival. Until these conditions improve, it is unlikely that directed fisheries will be prosecuted and it may be that escapements will fall below the goal range, even with reduced, but minor levels of indirect fishing.

#### 2.2.1.2.3 Stikine River

The Stikine River originates in British Columbia and flows into central Southeast Alaska near the towns of Petersburg and Wrangell. This is the largest river emptying into SEAK, glacial in origin, and supports a large, outside-rearing stock of Chinook salmon. Starting in 2005, during years of surplus production to the Stikine River, directed Chinook salmon fisheries were allowed in the marine waters in District 108 near Petersburg and Wrangell and in-river in Canada.

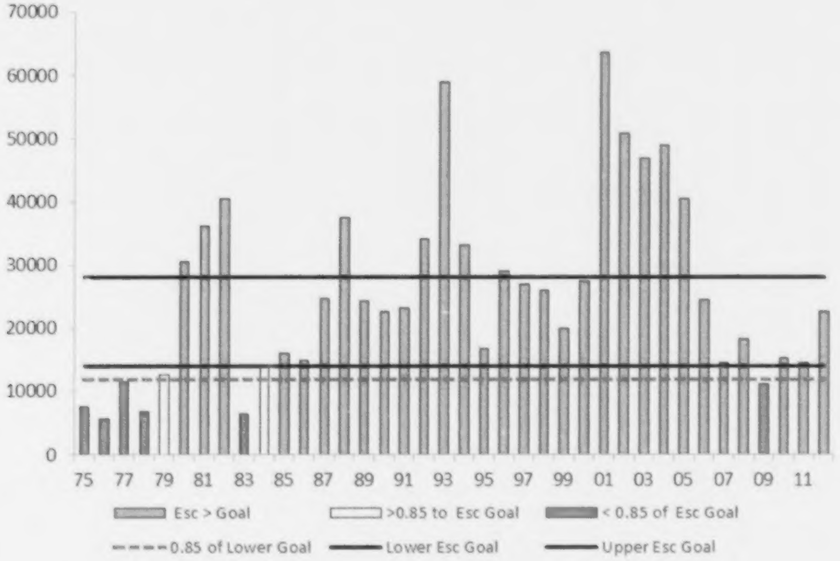


*Figure 2.2.1.2.3.–Stikine River escapements of Chinook salmon, 1975–2012.*

**Escapement Methodology**: From 1975 to 1984, index escapements were conducted using survey counts, and since 1985 counts were conducted using a weir at the Little Tahltan River. Since 1996, MR experiments were conducted annually to estimate total escapement. These studies indicate the weir counts represented 17% to 20% of the total escapement (Pahlke and Etherton 1999).

**Escapement Goal Basis**: An escapement goal of 14,000 to 28,000 large Chinook salmon (age-.3 to age-.5 fish) was established in 1999 after review and acceptance by the CTC, ADF&G, TBR Panel, and Canadian Science Advisory Pacific, based on the analysis in Bernard et al. (2000).

Previously, several system-wide or index goals were developed by the U.S. and Canada, and were based on limited data.

**Escapement Evaluation**: The Stikine River stock is reasonably healthy with annual escapements of less than 85% of the goal six times since 1975; however, this has only occurred once in the past 28 years (2009). The 2012 escapement was estimated to be 22,671 (CV = 0.16) large Chinook salmon, within the goal range (Figure 2.2.1.2.3).

**Agency Comments**: In recent years of directed Chinook salmon fishing, total harvest rates on Stikine River Chinook salmon are believed to have ranged between 50% and 70%. Most harvests occur in the U.S. commercial gillnet and sport fisheries in District 108 near Petersburg and Wrangell and in-river in the Canadian gillnet and aboriginal fisheries. CDFO and ADF&G currently operate joint programs to CWT smolt in order to estimate smolt and adult production, as well as exploitation. Since 1985, escapements to the Stikine River were within or above the escapement goal range except in 2009. Like the Taku River stock of Chinook salmon, the Stikine stock has demonstrated declining productivity over the past few years. The issue appears to be reduced marine survival. Until these conditions improve, it is unlikely that directed fisheries will be prosecuted and it may be that escapements will fall below the goal range, even with reduced, but minor levels of indirect fishing.

## 2.2.2 Canadian Stocks

Since the beginning of the Chinook salmon rebuilding program of the 1985 PST, escapement goals for Canadian Chinook salmon stocks were generally based on doubling the average escapements recorded from 1979 to 1982. The doubling was based on the premise that Canadian Chinook salmon stocks were overfished and that doubling the escapement would still be less than the optimal escapement estimated for the aggregate of all Canadian Chinook salmon populations (PSC 1991). Doubling was also expected to be a large enough change in escapements to allow detection of the change in numbers of spawners and the subsequent production. The escapement goals of the Canadian stocks are currently being reviewed.

### 2.2.2.1 *Northern British Columbia*

#### 2.2.2.1.1 Yakoun River

The CTC was unable to assess stock performance because the agency has not reported escapements since 2005. See Appendix Table B.2 for escapements through 2005.

#### 2.2.2.1.2 Nass River

The Nass River is the largest river in Area 3, representing a group of approximately 25 streams. It flows southwest from the BC interior into Portland Inlet and the estuary is only 30 km from the Alaska-BC border. The Nass River drains an area of approximately 18,000 $km^2$ and is constrained by a canyon at Gitwinksihlkw (GW). The canyon was formed by the Tseax volcano in 1775 and is approximately 40 km upstream from the estuary. The mainstem of the Nass River is extremely turbid with visibility near zero for most of the year. Among the major Chinook salmon producing tributaries, the Bell Irving River is glacially turbid while the Meziadin, Cranberry/Kiteen, Kwinageese and Damdochax rivers are relatively clear. Nass River Chinook salmon are primarily stream type and are thought to be far north migrating.

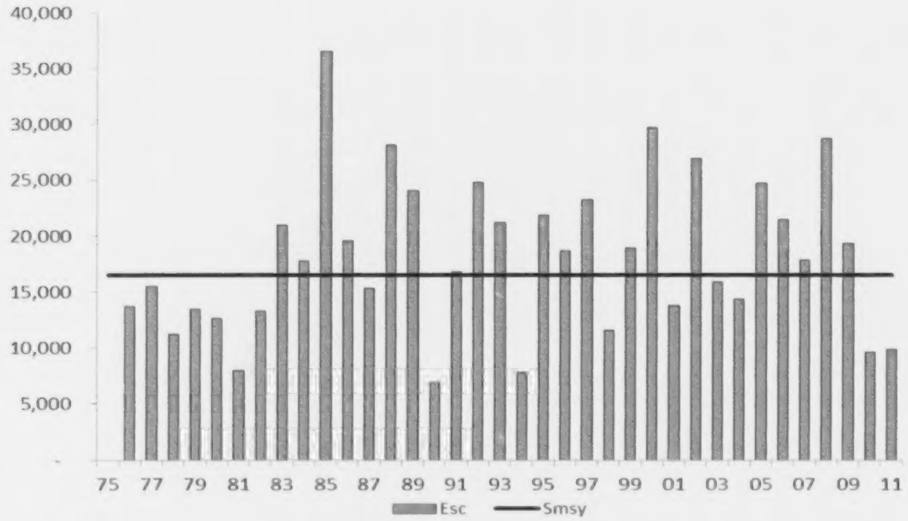


*Figure 2.2.2.1.2.–Nass River escapements of Chinook salmon, 1977–2012.*

**Escapement Methodology:** Prior to 1992, CDFO observations of Nass River Chinook salmon escapement were based on visual counts. Programs using MR have been conducted since 1992 by the Nisga'a Fisheries to estimate total spawning escapement in the Nass River. The Nass MR program uses two fish wheels at GW in the Lower Nass canyon and occasionally two wheels at Grease Harbor further upstream to apply tags. The Meziadin River fishway, a weir on the Kwinageese River and a deadpitch program on the Damdochax River are used for tag recovery. Tags were also recovered in upriver fisheries and on the spawning grounds. A modified Petersen model was used to estimate the total population of Chinook salmon past the tagging location. Spawning escapements were calculated as the estimated Chinook salmon population past GW from the MR studies, less upriver catches in sport and FN fisheries. Three tributaries with Chinook salmon populations, the Kincolith, Ishkeenickh and the Iknouk, enter the Nass River below GW. Visual estimates of these systems were augmented by fence counts of the Kincolith River in 2001, 2002, 2005 and 2007 to estimate escapements below the fish wheels.

**Escapement Goal Basis:** There is no CTC-accepted escapement goal for this stock. The Fisheries Operational Guidelines define two goals for managing Chinook salmon fisheries: an operational escapement target of 20,000 fish, and a minimum escapement target of 10,000 fish. If escapements are projected to be below 10,000 fish, then no fishing on Nass River Chinook salmon would be recommended. The median estimate of $S_{MSY}$ for the Nass River upstream of GW using the habitat model was 16,422 (CV = 23%) Chinook salmon based on a watershed area of 15,244 km$^2$ (Parken et al. 2006).

**Agency Comments:** Chinook salmon escapement estimates produced before 1992 have been calibrated to the MR estimates. The Nisga'a Fisheries Working group, including CDFO, has accepted the historical escapement and terminal run values (Appendix B.2). An SSP-funded project on the Kwinageese River and Damdochax Creek (Section 4.53 and Appendix C.11) is designed to increase recoveries and improve the escapement estimates for the Nass Chinook aggregate.

#### 2.2.2.1.3 Skeena River

The Skeena River is the second largest river in BC and drains an area of approximately 54,400 $km^2$. It supports the second largest aggregate of Chinook salmon stocks in BC with over 75 separate spawning populations. Four large-lake stabilized tributaries, the Kitsumkalum, Morice, Babine and Bear rivers, account for 65% of the total Chinook salmon abundance in the Skeena. The Kitsumkalum River is glacially turbid and visual methods for enumerating salmon are not appropriate. By comparison, other major Chinook salmon producing tributaries like the Morice, Bear, Babine and Kispiox rivers run relatively clear, especially in late summer when most of the Chinook salmon spawning occurs. Skeena River Chinook salmon are primarily stream-type (~97%) and are far north migrating. Most of the Skeena River Chinook salmon populations are summer run, but spring run fish occur in the Cedar River and the Upper Bulkley River.

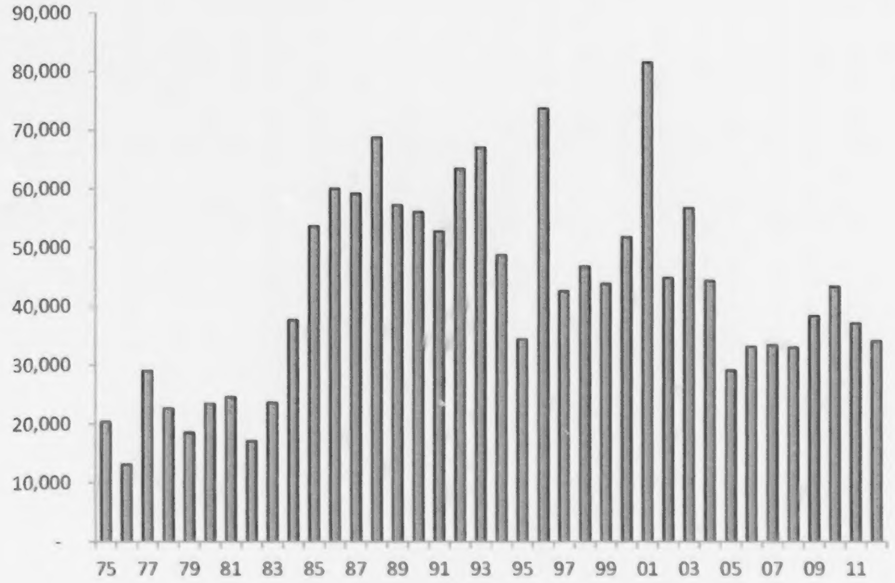


*Figure 2.2.2.1.3.1.–Skeena River escapements of Chinook salmon, 1975–2012.*

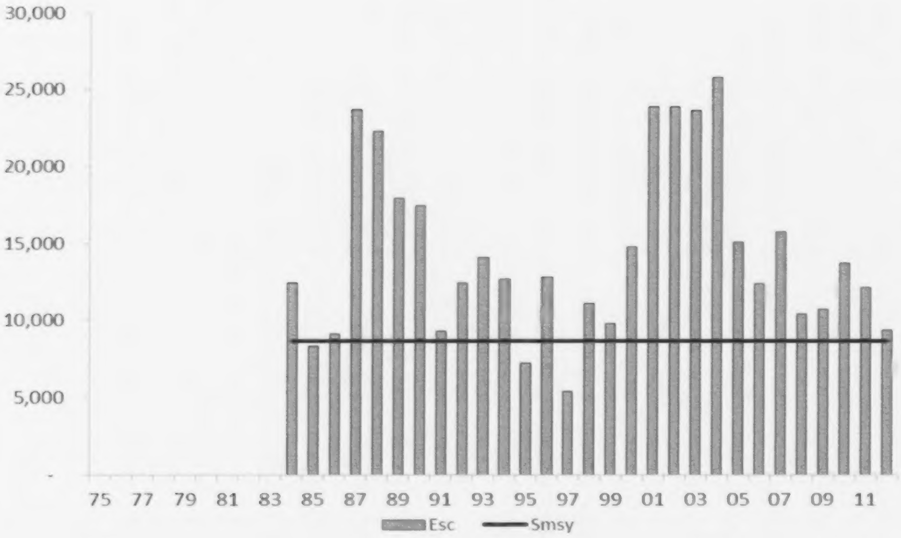


*Figure 2.2.2.1.3.2..–Kitsumkalum River escapements of Chinook salmon, 1984–2012.*

**Escapement Methodology**: Chinook salmon escapements to the Skeena River are represented by an index that includes approximately 40 populations surveyed annually using a variety of techniques. Most of the escapement estimates are based on visual observations from helicopter, fixed wing aircraft and/or from stream walking surveys. Fish counting weirs are present on the Babine, Sustut and Kitwanga rivers. The Kitsumkalum River is the exploitation rate indicator stock for the Skeena Chinook salmon aggregate and escapements have been estimated using a MR program since 1984. The Kitsumkalum represents approximately 30% of the spawners measured by the escapement index. The Bear and Morice river populations have contributed 20% and 26% to the escapement index respectively since 1984. Visual estimates for these systems tend to underestimate their actual contribution to the total escapement in the aggregate.

**Escapement Goal Basis:** There is no CTC-accepted escapement goal for the Skeena River aggregate. The estimate of $S_{MSY}$ for the Kitsumkalum indicator stock is 8,621 Chinook salmon based on stock-recruitment analyses (McNicol 1999; updated in Parken et al. 2006). Habitat-based estimates of $S_{MSY}$ and other reference points are available for stocks within the Skeena River, but estimates of total escapement (or calibration of the visual indices) are needed to make them effective (Parken et al, 2006). Future assessments will partition this large aggregate into stocks by run timing, life history and geographic areas.

**Agency Comments:** Terminal fisheries in the Skeena River normally include commercial gillnet in the terminal exclusion area (River Gap Slough, Area 4), in-river sport, and aboriginal fisheries. Estimates of in-river sport catch were not available from 1997 to 2002 but creel surveys were conducted on the Lower Skeena in 2003, 2010, 2011 and 2012. Consequently, the total terminal run estimates in these years include lower-river sport catch but no estimate of upper-river sport catch. Spawning escapements to the Kitsumkalum River have exceeded the point estimate of $S_{MSY}$ in every year since 1998. There are two SSP funded projects on the Skeena River (see Sections 4.5.1 and 4.5.2 and Appendix C.12) that provide estimates of total escapement for the Skeena River and its component tributaries. When complete, these projects will provide a 30-year time series of escapement estimates suitable for comparison with habitat-based or stock-recruit estimates of $S_{MSY}$ and capacity.

### 2.2.2.2 *Central British Columbia*

#### 2.2.2.2.1 Dean River

Chinook salmon populations in Area 8 consist of seven non-enhanced systems and the Bella Coola and Atnarko River system which is enhanced. Among non-enhanced systems the Dean River has the largest spawning population and the most consistent escapement surveys. Chinook salmon returning to the Dean River have summer timing and are predominantly stream type (94%).

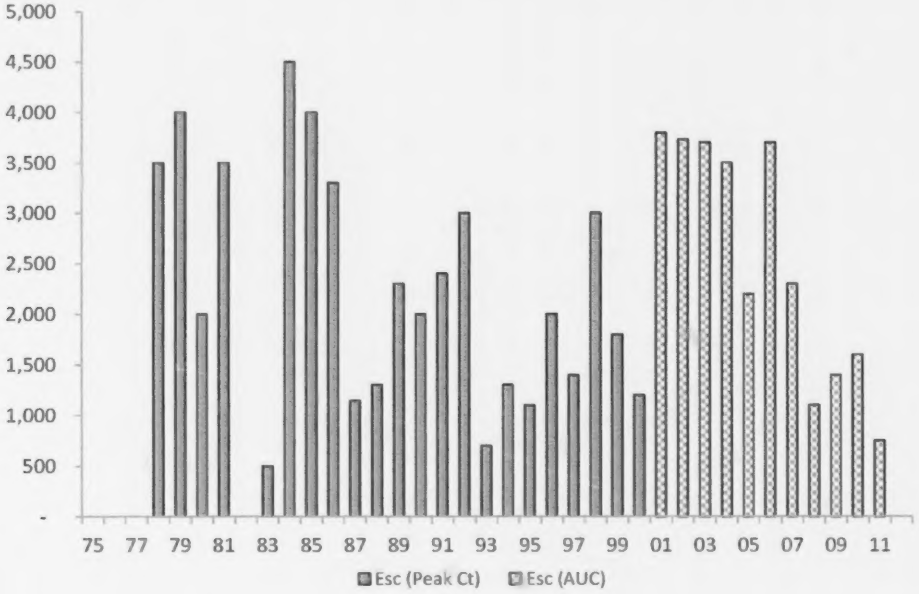


*Figure 2.2.2.2.1.–Dean River escapements of Chinook salmon, 1978–2012.*

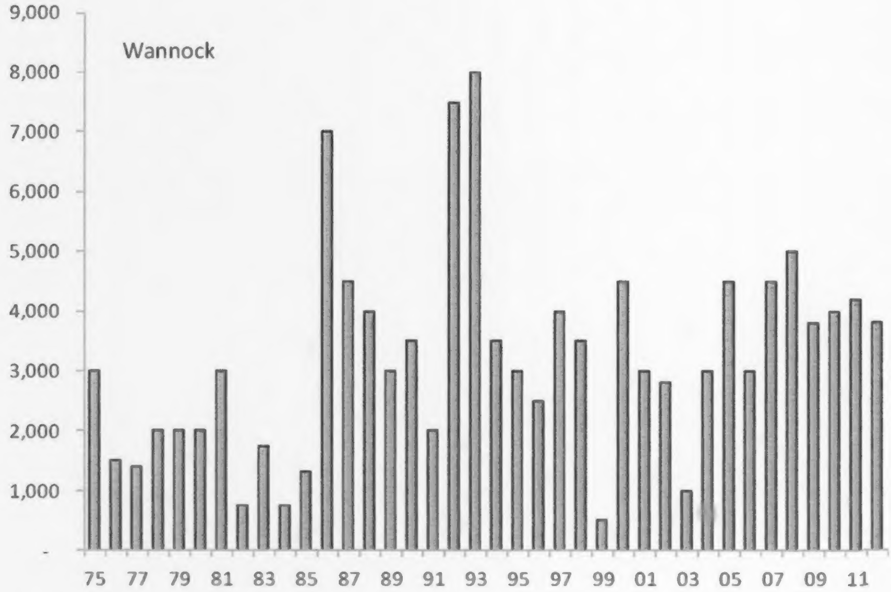
**Escapement Methodology:** Since 2001, the Chinook salmon escapement index for the Dean River has been derived using area-under-the-curve (AUC) methodology based on three aerial counts. In years where viewing conditions are poor, a maximum likelihood procedure has been used (e.g., 2004). A Chinook salmon MR program was conducted on the Dean River in 2006 to develop an expansion factor for converting the escapement indices into estimates of total escapement. The preliminary estimate of escapement based on the MR program was 5,478 compared to the maximum likelihood estimate of 3,689 (factor = 1.49).

**Escapement Goal Basis:** There is no CTC-accepted escapement goal for this stock. Biologically-based goals for this complex of Chinook salmon spawning populations have not yet been developed. Habitat-based estimates of $S_{MSY}$ and other stock-recruitment reference points are available for the Dean River (median $S_{MSY}$ = 3,646, CV = 14%), but estimates of total escapement are needed to make them effective

**Agency Comments:** Chinook salmon escapement was not estimated in 2012, however the escapement assessment program is expected to resume in 2013.

### 2.2.2.2.2 Rivers Inlet

The Rivers Inlet escapement index consists of an aggregate of Chinook salmon escapements to the Wannock, Kilbella and Chuckwalla rivers. The Wannock River drains Owikeno Lake into the head of Rivers Inlet. It is about 6 km long, over 100 m wide and is glacially turbid. Wannock Chinook salmon are genetically distinct from other Chinook salmon populations in the central coast of British Columbia. This ocean-type stock exhibits fall run timing and is renowned for its large body size, due to ocean-age-4 and ocean-age-5 year components in the return. The Kilbella and Chuckwalla river systems share an estuary on the north shore of Rivers Inlet. These systems are relatively small and can run clear but are often turbid as a result of precipitation. The Chinook salmon populations in the Chuckwalla and Kilbella rivers have summer run timing and are stream-type. The largest contributor to the index is the Wannock River which represents an average of 76% of the production for this index over the past decade and over 90% recently.



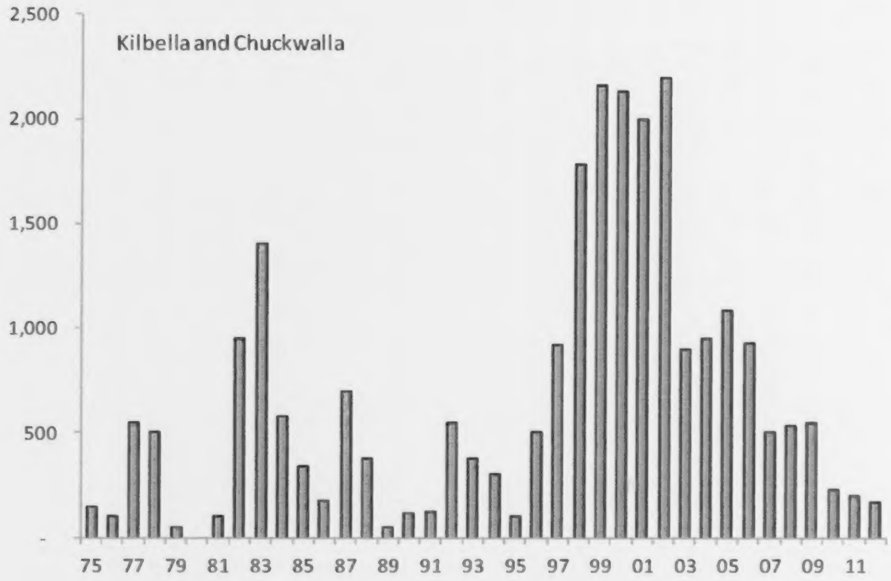


*Figure 2.2.2.2.2.–Rivers Inlet escapement index of Chinook salmon, 1975–2012, including Wannock, Kilbella and Chuckwalla rivers.*

**Escapement Methodology**: Chinook salmon escapement estimates for the Wannock River are produced from an annual carcass recovery program. Estimates are derived by expanding the number of carcasses pitched based on historical recovery rate assumptions. Expansion factors are somewhat subjective and take into consideration water clarity, river height, and recovery effort. The visual index estimate for Wannock Chinook salmon in 2012 was 3800 based on expansion of carcass recoveries during the traditional deadpitch program. Programs to calibrate carcass recoveries with population estimates from MR experiments were conducted from 1991 to 1994 and again in 2000. Results suggest the estimates based on the subjective expansions of carcass recoveries underestimate the Wannock Chinook salmon population by approximately half. Inherent bias as well as imprecision in the MR estimates leads to uncertainty in calibration of the carcass estimates.

Chinook salmon escapements for the Chuckwalla and Kilbella rivers are estimated using AUC methods applied to visual counts from helicopter surveys. Typically four flights are made during the spawning period. Three assessment flights of the Kilbella and Chuckwalla rivers were completed in 2012; however, zero Chinook salmon were observed in the Chuckwalla River and escapement was below the level detectable. The estimated escapement to the Kilbella River was 170.

**Escapement Goal Basis:** There is no CTC-accepted escapement goal for these stocks. Habitat-based estimates of $S_{MSY}$ and other stock-recruitment reference points are available but estimates of total escapement are needed to make them effective. Habitat-based escapement goals were thought to overestimate $S_{MSY}$ for the Wannock River because the stock may be limited by the relatively small amount of spawning area available (Parken et al. 2006).

**Agency Comments:** A small enhancement program occurs on the Wannock River but the contribution to the total population is unknown. Production from enhancement of the Kilbella and Chuckwalla rivers from 1990 to 1998 is thought to have had significant influence on escapements from 1994 to 2003 but estimates of the enhanced component are not available. Estimated returns to the Chuckwalla and Kilbella averaged 1300 Chinook salmon during the period of enhancement. Recent returns have averaged less than 500 Chinook salmon for both rivers combined and it is unclear if these populations have returned to pre-enhancement levels or are experiencing an unrelated decline.

#### 2.2.2.2.3 Atnarko River

Following the 2009 Agreement, a CWT Improvement Program was initiated to improve the CWT system, including CWT reporting systems, data quality, tagging levels, sampling levels, and the precision and accuracy of statistics such as abundance, exploitation rates, survival estimates, etc. for Chinook salmon. Upon review of notable deficiencies, the lack of a Chinook salmon indicator in the Central BC region was highlighted. In order to convert the existing Atnarko Chinook Assessment program into an exploitation rate indicator, a series of objectives were identified including the application of 250,000 incremental CWTs, sampling of the terminal commercial, sport and FN fisheries, and reintroduction of a MR program to improve escapement estimates. Implementation of these changes began in 2009 and subsequent MR programs have yielded escapement estimates with corresponding CVs of less than 15% for all years except for 2012 (CV = 16%).

The Northern BC CTC model stock group is represented by Kitsumkalum River which is a stream-type stock, while the Atnarko River which feeds the Bella Coola River and is situated in Statistical Area 8 on the Central Coast of BC is predominantly an ocean-type stock. It constitutes the largest complex of Chinook salmon in Central BC. Hatchery releases of Atnarko Chinook salmon have averaged around 2 million annually with recent CWT releases in excess of 400,000. Atnarko CWT recoveries occur in both U.S. and Canadian AABM fisheries as well as coastal BC ISBM fisheries.

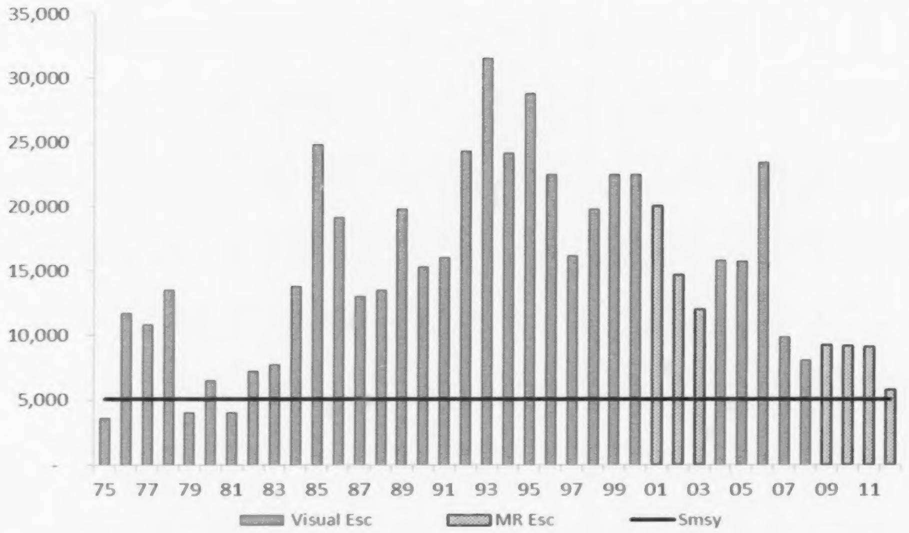


*Figure 2.2.2.2.3.–Atnarko River escapements of Chinook salmon, 1975–2012. Petersen MR estimates are also provided for 2001–2003 and 2009–2012.*

**Escapement Methodology**: Atnarko River Chinook salmon escapements have primarily been estimated using the three-method) average (3M Average). The 3M Average includes methods derived from (i) average of peak drift counts; (ii) brood stock capture CPUE; and (iii) number of carcasses pitched. Population estimates derived using the 3M Average show no significant difference from Petersen estimates produced in years of MR programs (Wilcoxon matched pair test: $z = 0.94$; $p = 0.35$) with the Petersen estimate being on average 97% (SD = 12%) of the estimate produced by the 3M Average method (Vélez-Espino et al. 2011). A serious flood event in the fall of 2010 impacted the Atnarko by altering flow dynamics and creating a sequence of obstructive log jams. As a result, the use of rafts to obtain drift counts was no longer feasible; subsequently, traditional population estimates beginning in 2011 have been derived using only the brood stock capture CPUE and number of carcasses pitched. This change in methodology is identified as the two-method average (2M Average). Recent brood stock CPUE data are not likely comparable with that of the pre-flood period as the pools used for broodstock collection have been negatively altered and may not be as conducive to these efforts as in the past.

**Escapement Goal Basis:** There is no CTC-accepted escapement goal for Atnarko Chinook salmon. The median estimate of $S_{MSY}$ for the Atnarko River using the habitat model is 5,048 (CV = 13%) Chinook salmon.

**Agency Comments:** The Atnarko River has been developed as an exploitation rate indicator stock (Velez-Espino et al. 2011). MR estimates with corresponding CVs less than 15% have been attained in six of seven program years. Following completion of the five-year CWT program in 2013, MR derived escapement estimates will be assessed against the 3M Average estimates in an effort to recalibrate the 1990 to 2013 time series.

### 2.2.2.3 *West Coast Vancouver Island and Georgia Strait*

#### 2.2.2.3.1 West Coast Vancouver Island

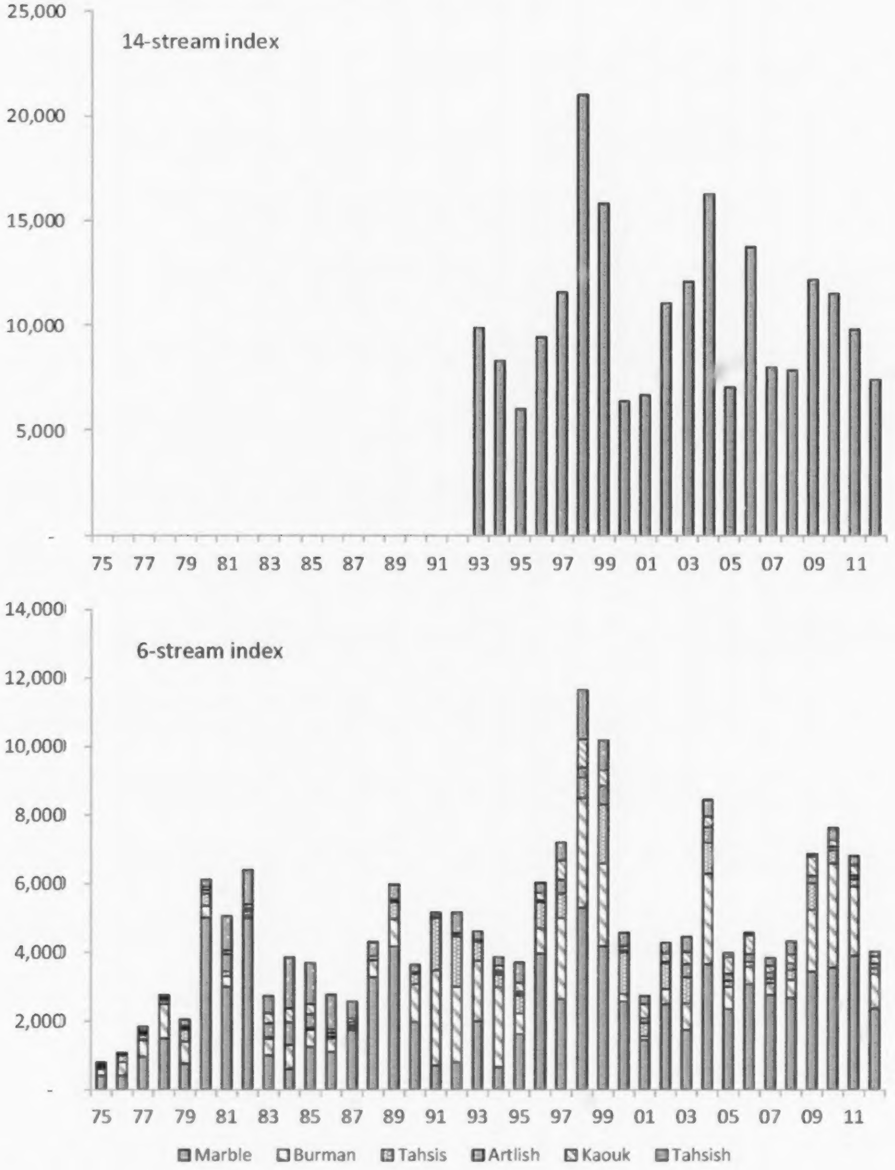


*Figure 2.2.2.3.1.–The WCVI Index of escapement includes both a 14-stream and a 6-stream index. The escapement methodology changed for the six-stream index in 1995 and prior estimates have not been calibrated to the new methodology.*

**Escapement Methodology:** The WCVI index represents the sum of escapements for six rivers (Marble, Tahsis, Burman, Artlish, Kaouk, and Tahsish), which were chosen to provide an index of escapement for wild WCVI stocks in general. These stocks were chosen based on historical consistency of data quality, although the escapement methodology changed in 1996 and prior estimates have not been calibrated to the new methodology. CDFO has developed a 14-stream expanded index which includes escapements to the 6-stream index plus the following WCVI streams: Colonial and Cayegle creeks (Area 26), Leiner (Area 25), Megin, Bedwell/Ursus, Moyeha (Area 24) and Sarita, Nahmint (Area 23), and San Juan (Area 21). In 2005, the Colonial/Cayegle escapement was not available, and was therefore not included in the 14-stream index. Since 2007, a MR program has been conducted on the Burman River, a SSP-funded project (Section 4.3.2 and Appendix C.6), in addition to the regular swim and foot surveys. However, the escapement estimate used for the index followed the same methodology since 2005.

**Escapement Goal Basis:** There is currently no CTC-accepted escapement goal for this stock group.

**Agency Comments:** Habitat-based estimates of $S_{MSY}$ and other stock-recruitment reference points are available for these stocks (Parken et al. 2006), but estimates of total escapement are needed to make them effective. Work is currently underway to estimate total escapements as part of the SSP-funded projects since 2009, and in 2012 projects occurred at the Burman, Marble, Tahsis and Leiner rivers (Section 4.3.2 and Appendix C.6). WCVI Chinook salmon have remained below the agency goals for these streams since 1999 despite terminal fishing closures in effect in Areas 24–26 from July to September each year and efforts to conserve WCVI Chinook salmon in Canadian fisheries. Escapements to all non-enhanced Clayoquot Sound and Kyuquot Sound Chinook salmon streams in the indices remain below 500 fish.

#### 2.2.2.3.2 Upper Georgia Strait

The Upper Strait of Georgia (UGS) stock index consists of five rivers (Klinaklini, Kakweiken, Wakeman, Kingcome, Nimpkish). Four are in Johnstone Strait mainland inlets and the Nimpkish River is on northeast Vancouver Island.

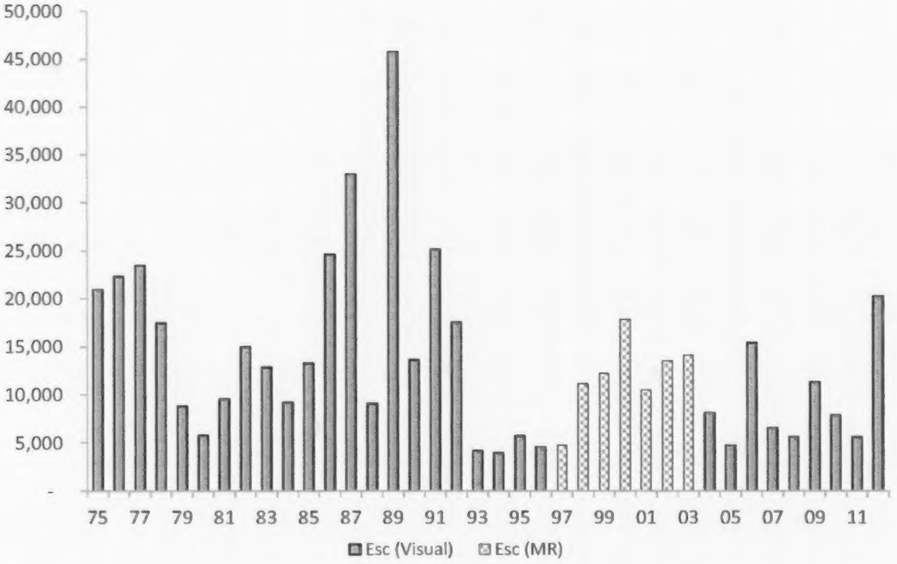


*Figure 2.2.2.3.2.–Upper Georgia Strait stock group escapements of Chinook salmon, 1975–2012.*

*Note: The hatched bars in the histogram represent years when escapements to the Klinaklini River were estimated using Fishwheel MR methods while the solid bars indicate estimates based on visual surveys.*

**Escapement Methodology:** The accuracy of escapement estimates in the mainland inlet systems is likely poor due to low visibility of glacial systems, remote access, and timing of surveys. Escapement estimates have primarily been based on aerial counts targeting other salmon species, which may not coincide with the main spawning period for Chinook salmon. Swim surveys and stream walks have been conducted in the Nimpkish River. A fish wheel program occurred on the Klinaklini River from 1997 to 2004. The escapement time series for the Upper Strait of Georgia stock group has been revised this year and varies from the series reported previously. The revised time series now includes estimates based on consistent methods within each river, and escapements to rivers missing escapement data for some years (i.e. no surveys) were estimated using the procedures described by English et al. (2007).

**Escapement Goal Basis**: There is currently no CTC-accepted escapement goal for this stock group.

**Agency Comments:** Assessment of stock status is highly uncertain and the escapement time series requires standardization to better represent this stock group in the PSC Chinook Model. Differences in ocean distributions, run timing, and life history indicate that future assessments should separate the stock group into conservation units.

#### 2.2.2.3.3 Lower Georgia Strait

The LGS natural rivers monitored for naturally spawning fall Chinook salmon escapement are the Cowichan and Nanaimo rivers (Figure 2.2.2.3.3.1 and Figure 2.2.2.3.3.2).

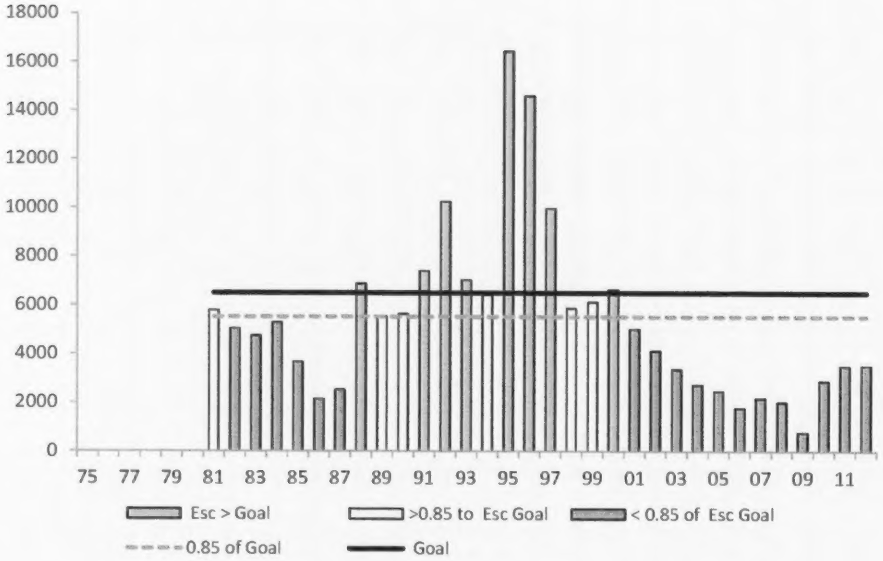


*Figure 2.2.2.3.3.1..–Cowichan River escapements of Chinook salmon, 1981–2012.*

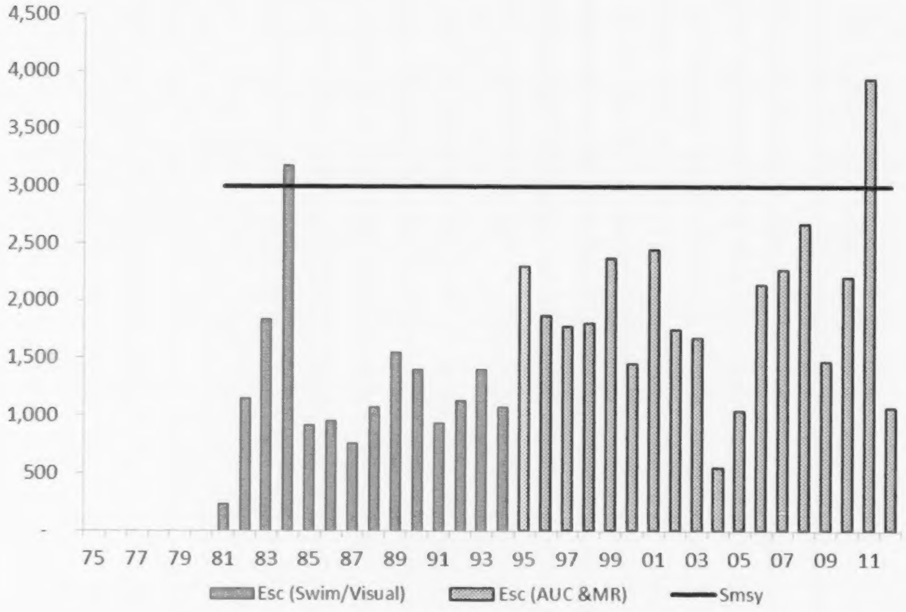


*Figure 2.2.2.3.3.2.Nanaimo River escapements of Chinook salmon, 1981–2012.*

**Escapement Methodology:** Total Chinook salmon returns have been estimated since 1975. Prior to 1988, escapement estimates from the Cowichan River were derived from swim and aerial surveys. This approach was also used for the Nanaimo River prior to 1995. Since 1988 a counting fence has been used in the Cowichan River. Between 1995 and 2004 carcass MR surveys were used in the Nanaimo River, and since 2005, AUC methods have been used. Survey life is based on a tagging study in 2006.

**Escapement Goal Basis:** An escapement goal of 6,500 (CV = 33%) for the Cowichan River was accepted by the CTC in 2005 (Tompkins et al. 2005). There is currently no CTC-accepted escapement goal for the Nanaimo River; however, it has a habitat-based estimate for $S_{MSY}$ of 3,000 spawners (median; CV = 14%; Parken et al. 2006).

**Agency Comments:** The Cowichan River stock showed considerable increase in 1995 and 1996, followed by a rapid decline to conservation concern levels more than 15% below the escapement goal. Significant Canadian fishery management actions are used to reduce exploitation levels on the LGS natural stock group.

### 2.2.2.4 *Fraser River Stocks*

The Fraser River watershed is the largest Canadian producer of Chinook salmon. Fraser Chinook salmon consist of many local populations as described in CTC (2002b).

Much of the knowledge about the status of Fraser River Chinook salmon is based on spawner escapement data. Most data are from visual surveys, which are generally biased low, although many estimates are considered to be reasonably precise. Visual survey data are generated from aerial surveys and the escapement estimate is usually obtained by dividing the peak count by 0.65 (Farwell et al. 1999). The CDFO continues to evaluate the appropriateness of this expansion factor and AUC methodology through calibration studies. MR projects exist for some systems, and fishways or resistivity counters are being employed in a few others, although most of the time series of escapement data from these projects are relatively short compared to the aerial estimates.

Currently, Fraser River Chinook salmon are assessed as five aggregates for PSC management, (Fraser spring run age 1.2, Fraser spring run age 1.3, Fraser summer run age 1.3, Fraser summer run age .3, and Fraser late) however Fraser River Chinook salmon are only represented by two stocks in the CTC model, Fraser early and Fraser late. Work is underway to upgrade Fraser representation in the model by parsing Fraser Early into the four constituent life history based populations.

Within the Fraser, there are four current CWT-indicator stocks: Nicola River (Fraser spring run age-1.2), Lower Shuswap (Fraser summer run age .3), and Harrison River and Chilliwack River for Fraser late. Dome Creek (Fraser spring run age 1.3) CWT application and recovery (Fraser spring run age 1.3) was discontinued in 2005. Of the four aggregate populations comprising the Fraser early model stock, three are thought to be dominated by offshore migrant yearling Chinook salmon, while the fourth, Fraser summer run age .3 are far-north migrating, and contribute significantly to fisheries in NBC and SEAK.

Only the Harrison River has a CTC-approved escapement goal. For populations other than the Harrison River, habitat-based models are being developed to estimate spawning capacity and spawner abundance producing MSY (Parken et al. 2006). This habitat-based assessment will initially focus on predictive models based on Chinook salmon stock-recruitment relationships, although other habitat-based approaches will also be considered.

Escapements to the three yearling aggregates declined steeply between 2003 and 2009, and yearling smolts that entered the ocean in 2005 and 2007 faired particularly poorly. Recent returns indicate that the decline may have been halted; however, rebuilding progress has been particularly slow, especially in the spring run age 1.2. In contrast, escapements to the Fraser summer run age .3 built and remained very strong until 2012, when they declined steeply, like many other far-north migrating stocks.

Returns to the Fraser late stock failed to meet the escapement goal in 2012.

### 2.2.2.4.1 Fraser River Spring Run: Age 1.3

The Fraser River spring run age-1.3 aggregate includes the Upper Pitt River and Birkenhead River stocks in the Lower Fraser, and the spring run stocks of the Mid- and Upper Fraser, North Thompson, and South Thompson, but excluding those of the Lower Thompson tributaries (CTC 2002b).

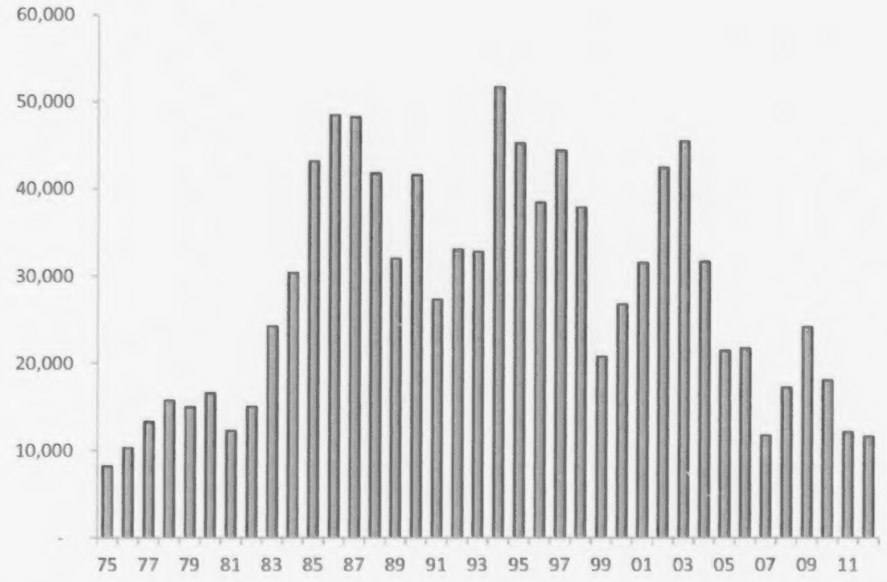


*Figure 2.2.2.4.1.–Fraser River spring run age-1.3 stock group escapements of Chinook salmon, 1975–2012.*

**Commentary:** Escapements are mostly estimated by expanded peak live counts of spawners, holders and carcasses, surveyed from helicopters or on foot. Escapements continued to decline in 2012, and also just failed to exceed the parental brood escapement levels in 2007. Escapement to the aggregate was estimated at 11,584 in 2012.

**Escapement Goal Basis:** There is currently no CTC-accepted escapement goal for this aggregate. Habitat-based estimates of $S_{MSY}$ and other stock-recruitment reference points are available for this stock group, but estimates of total escapement are needed to make them effective. Work is currently underway to estimate total escapements by developing factors that calibrate the visual survey indices to total escapements estimated by MR and electronic resistivity counter methods.

**Agency Comments:** The stock group has declined substantially over the last decade and is a stock of conservation concern.

### 2.2.2.4.2 Fraser River Spring Run: Age 1.2

The Fraser River spring run age-1.2 aggregate includes six populations that spawn in the Lower Thompson River tributaries, Louis Creek of the North Thompson and the spring-run fish of Bessette Creek in the South Thompson (CTC 2002b). This stock group has a early maturation schedule for a stream-type life history, with an average generation time of 4.1 years (brood years 1985–1986), which results in smaller body size and lower fecundity compared to many other stock groups.

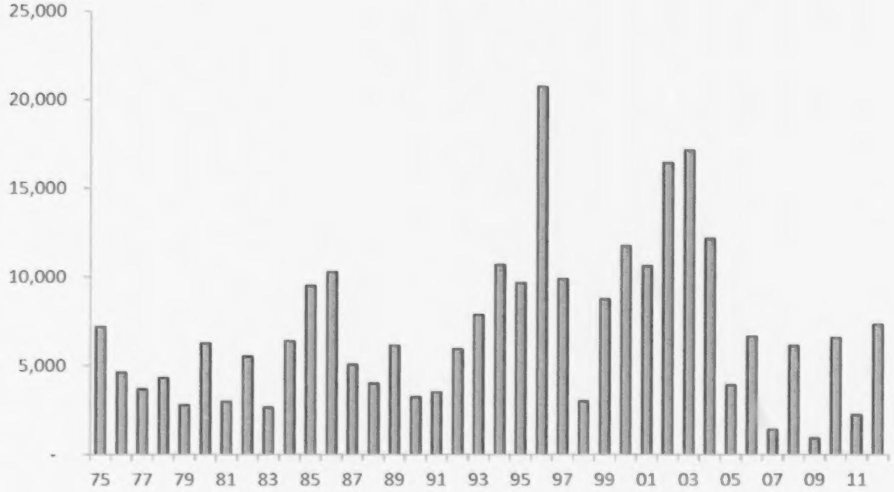


*Figure 2.2.2.4.2.–Fraser River spring run age 1.2 stock group escapements of Chinook salmon, 1975–2012.*

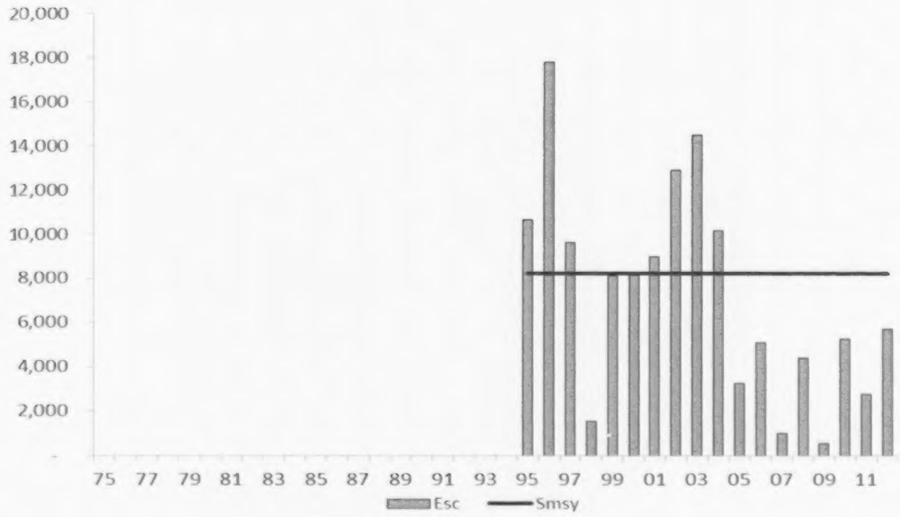


*Figure 2.2.2.4.3.–Nicola River escapements of Chinook salmon, 1995–2012.*

**Escapement Methodology:** For the CTC time series, escapements are estimated visually using expanded peak counts of spawners, holders and carcasses in the Nicola River, Spius Creek, Coldwater River, Louis Creek and Bessette Creek. Escapements to the Deadman River are estimated by resistivity counter. Escapements improved in 2012 from levels observed in 2011, and escapements also exceeded those of the 2008 parental brood. Aggregate escapement was estimated at 7,314.

The Nicola River is the exploitation rate indicator stock for the Fraser River spring run age-1.2 stock group. A MR program provides the high precision estimates of escapement by age and sex, and since 1995, Petersen disk tags have been applied by angling and post-spawned salmon carcasses examined for the presence of marks. Estimates of escapement have been generated using pooled Petersen methods. The expanded peak count time series for the Nicola River is generally less than the MR estimates (Parken et al. 2003), and calibration of the complete time series of peak count estimates is in progress. The Nicola peak count series is included in the Fraser spring run age-1.2 aggregate time series. The MR estimated escapement of 5,702 is well above that observed in 2011 (2,745), and the 2012 escapement also exceeded that of the 2008 parental brood (4,411). Since 1995 hatchery origin fish averaged 26% of the spawning escapement (range: 4%–71%).

**Escapement Goal Basis:** There is currently no CTC-accepted escapement goal for this aggregate. Habitat-based estimates of $S_{MSY}$ and other stock-recruitment reference points are available for this stock group (Parken et al. 2006), but estimates of total escapement are needed to make them effective. Work is currently underway to estimate total escapements by developing factors that calibrate the visual survey indices to total escapements estimated by MR and electronic resistivity counter methods. Since 2004, the Nicola River escapements have been less than the median estimate of $S_{MSY}$ (9,300; CV 21%).

**Agency Comments:** The stock group has declined substantially over the last decade and is a stock of conservation concern.

### 2.2.2.4.3 Fraser River Summer Run: Age 1.3

The Fraser River summer run age-1.3 aggregate includes 10 populations spawning in large rivers, mostly below the outlets of large lakes. These include the Nechako, Chilko and Quesnel rivers in the Mid-Fraser and the Clearwater River in the North Thompson watershed (CTC 2002b).

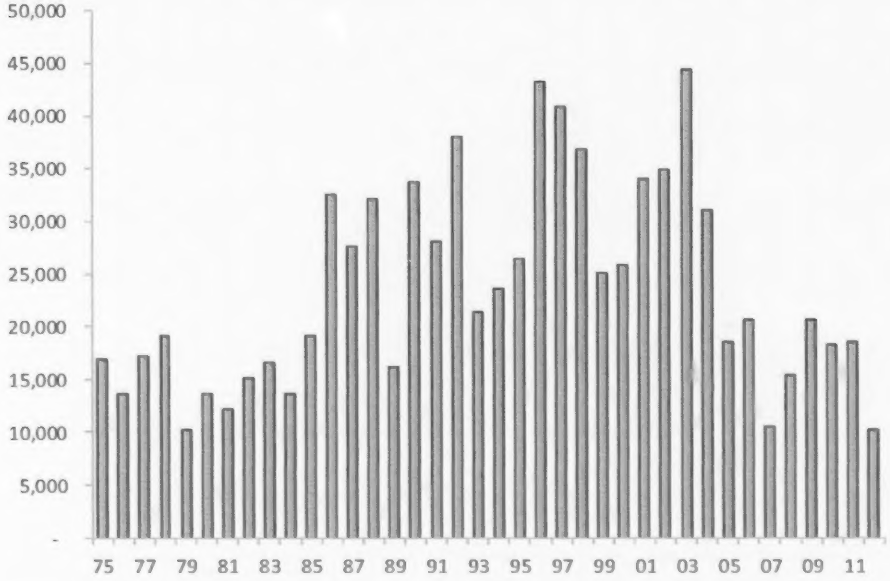


*Figure 2.2.2.4.4.–Fraser River summer run Age 1.3 stock group escapements of Chinook salmon, 1975–2012.*

**Escapement Methodology:** Escapements are estimated by expanded peak counts of spawners, holders and carcasses surveyed from helicopters. Surveys of the Stuart River and North Thompson River were discontinued in 2004 due to unreliable counting conditions. Escapements in 2012 declined substantially from those observed in 2010 and 2011, however, they were very similar to those observed in the parental brood year in 2007. Aggregate escapement was estimated at 10,180.

**Escapement Goal Basis:** There is currently no CTC-accepted escapement goal for the aggregate. Habitat-based estimates of $S_{MSY}$ and other stock-recruitment reference points are available for this stock group, but estimates of total escapement are needed to make them effective. Work is currently underway to estimate total escapements by developing factors that calibrate the visual survey indices to total escapements estimated by MR and AUC methods.

**Agency Comments:** The stock group has declined over the last decade and is a stock of conservation concern.

#### 2.2.2.4.4 Fraser River Summer Run: Age .3

The Fraser River summer run age-.3 aggregate includes six populations spawning in the South Thompson watershed and one in the Lower Fraser. These include the Middle Shuswap, Lower Shuswap, Lower Adams, Little River and the South Thompson River mainstem, in the BC interior, and Maria Slough in the Lower Fraser River (CTC 2002b).

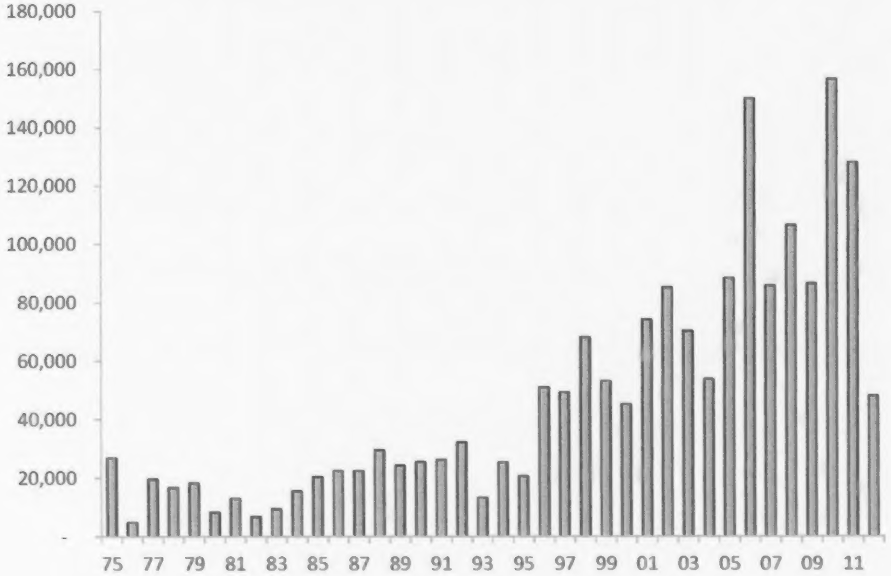


*Figure 2.2.2.4.5.–Fraser River summer run age-.3 stock group escapements of Chinook salmon, 1975–2012.*

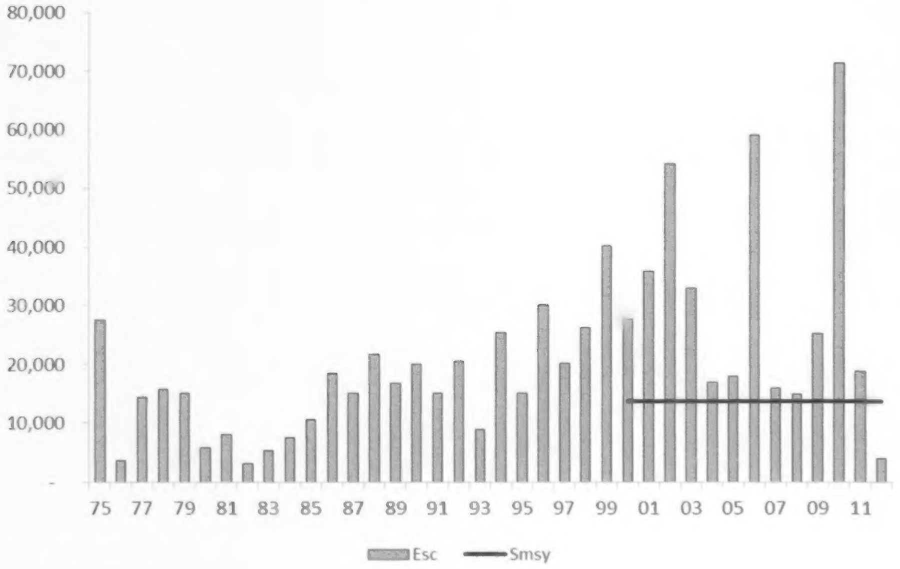


*Figure 2.2.2.4.6.–Lower Shuswap River escapements of Chinook salmon, 1975–2012. The visual escapement estimates have been calibrated with the MR estimates.*

**Escapement Methodology:** Escapements are estimated using peak count visual survey methods. Escapements to the summer run age-.3 aggregate declined steeply in 2012, and were the lowest estimated since 1996 (47,621), approximately 45% of the parental brood year escapements in 2008. Escapements to the Middle Shuswap River were particularly poor. The estimated escapement was 286; only 20% of the estimated parental escapement in 2008 (1,418).

The Lower Shuswap River is the exploitation rate indicator stock for the Fraser River summer run age-.3 stock group, and a MR program provides the high precision estimates of escapement by age and sex. Since 2000 (with the exception of 2003), tags have been applied to live fish by seining and salmon carcasses were examined later for the presence of marks. The visual escapements are calibrated values that have been estimated using a relationship between MR and peak methods. The Lower Shuswap peak count series (uncalibrated) is included in the Fraser River summer run age-.3 aggregate time series. The 2012 estimated escapement of 3,958 is substantially lower than that observed in 2011 (18,874), and represents only 27% of the 2008 parental brood of 14,921. Since 2000, hatchery origin fish averaged 6% of the spawning escapement (range: 2%–13%).

**Escapement Goal Basis:** There is currently no CTC-accepted escapement goal for the aggregate. Habitat-based estimates of $S_{MSY}$ and other stock-recruitment reference points are available for this stock group (Parken et al. 2006), but estimates of total escapement are needed to make them effective. Work is currently underway to estimate total escapements by developing factors that calibrate the visual survey indices to total escapements estimated by MR methods and novel methods via the SSP. Prior to 2012, Lower Shuswap River escapements have exceeded the median estimate of $S_{MSY}$ (12,800; CV = 37%); however, the 2012 escapements represent only 30% of the median estimate of $S_{MSY}$.

**Agency Comments:** Escapements had been increasing for this stock group over the last decade and the stock group has been healthy and abundant.

### 2.2.2.4.5 Fraser River Late Run (Harrison River)

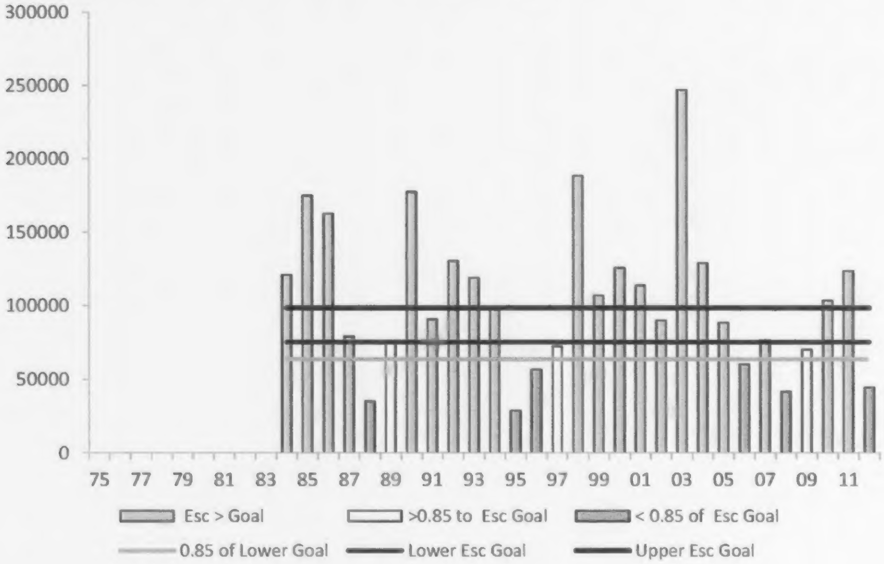


*Figure 2.2.2.4.7.–Harrison River escapements of Chinook salmon, 1984–2012.*

**Escapement Methodology:** Since 1984, MR studies have been conducted annually on the Harrison River to obtain reliable estimates of spawning escapements. Spawning escapements to the Harrison River in 2012 were estimated to be 44,467 adult Chinook salmon, and 11,409 jacks.

**Escapement Goal Basis:** Due to their natural abundance and importance in numerous British Columbia and Washington State fisheries, Harrison River Chinook salmon were designated as an escapement indicator stock (i.e., 'key stream' indicator) to aid in fulfilling commitments under the 1985 PST. In 1986, an interim escapement goal for Harrison River Chinook salmon was established at 241,700 fish, based on doubling of the escapement estimate obtained from a MR program in 1984. In 2001, an escapement goal range was developed for Harrison Chinook salmon using a Ricker stock-recruit approach and is described in CTC (2002b). The escapement goal range that was proposed was 75,100 to 98,500 (CV = 15%) with the upper bound equal to the upper 75% confidence limit derived from a bootstrap procedure. This range was reviewed and accepted by the CTC. Estimated spawning escapements in the Harrison have exceeded this escapement goal range in nine years from 1984 to the present. Escapements have fluctuated substantially with no apparent trend in the time series. This stock is forecast to be below 85% of the escapement goal in 2013.

**Agency Comments:** Harrison River Chinook salmon are white-fleshed fish that return to spawn during the fall. They are unusual in that fry migrate into the Lower Fraser River and estuary shortly after emergence. This stock spends two to four years in the coastal marine environment before returning to spawn. The Harrison River stock is one of the largest naturally spawning Chinook salmon populations in the world and makes important contributions to fisheries in southern BC, and Washington State.

## 2.2.3 Puget Sound, Coastal Washington, Columbia River, and Coastal Oregon Stocks

The PSC escapement indicator stocks in Washington and Oregon are separated into five regional groups: Puget Sound, Washington Coastal, Columbia River, North Oregon Coastal, and Mid-Oregon Coastal. The indicator stocks include a variety of run timings and ocean distributions. Some of these indictor stocks are components in the different stock groups listed in Attachment I–V tables in the 2009 Agreement.

Biologically-based escapement goals have been reviewed and accepted by the CTC for three fall stocks (Queets, Quillayute, Hoh as part of the Washington Coastal fall natural stock group), two spring/summer stocks (Queets, Hoh), four Columbia River stocks (Lewis, Upriver brights and Deschutes as the Columbia River fall stock group and the Columbia River summer stock group), and three Oregon coastal stocks (Nehalem, Siletz and Siuslaw as the far north migrating Oregon Coastal Falls stock group).

### 2.2.3.1 *Puget Sound*

Puget Sound escapement indicator stocks include spring, summer/fall and fall Chinook salmon stocks from the Nooksack, Skagit, Stillaguamish, Snohomish, Lake Washington, and Green river systems. They tend to have a more local distribution than most coastal and Columbia River stocks and are caught primarily in WCVI AABM fisheries, and Canadian and U.S. ISBM fisheries. Escapement for these stocks is assessed as the total number of natural- and hatchery-origin fish spawning naturally on the spawning grounds.

#### 2.2.3.1.1 Nooksack River

The Nooksack River drains into Puget Sound near Bellingham. The Nooksack spring Chinook salmon stock includes early timed populations returning to the north and south forks of the Nooksack River.

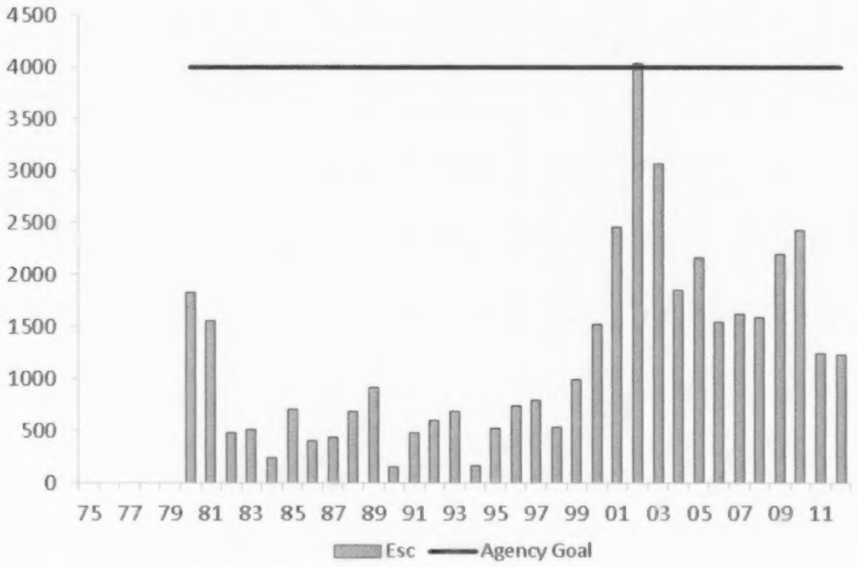


*Figure 2.2.3.1.1.–Nooksack River escapement of natural- and hatchery-origin spring Chinook salmon, 1980–2012.*

**Escapement Methodology:** Estimates of the escapement in the south fork have traditionally been based on the number of redds observed prior to the first of October expanded by 2.5 redds per spawner. Since 1999, this estimate has been further refined by separating hatchery-origin strays (North/Middle Fork and summer/fall Chinook salmon) based on CWTs, otolith marks or adipose fin clips, and also by assigning the natural-origin spawners to the south fork, north/middle fork and summer/fall hatchery stocks. The latter step is based on the expansion of the microsatellite DNA stock assignment of carcasses collected through the first week of October applied to the total estimated natural-origin spawners. The majority of the run and the natural escapement is composed of hatchery-origin returns from the supplementation program. During the period from 1999 to 2008, only 15% of the escapement in the north fork and 50% of the escapement in the south fork was composed of natural-origin fish, annually ranged between 117 to 390 fish combined (CCMP 2010). In 2012, the natural escapement estimate was 759 for the north fork and a projected 466 for the south fork using the relationship between the north fork and south fork in 2011.

**Escapement Goal Basis:** There is currently no CTC-accepted escapement goal for this stock.

**Agency Comments:** The state–tribal escapement goal established for this Chinook salmon management unit is an upper management threshold (UMT) of 4,000 spawners and a low abundance threshold (LAT) of 2,000 natural-origin fish (CCMP 2010). The UMT as established by the state–tribal managers is generally considered as the adult (age 3+) escapement level associated with maximum sustained harvest (MSH). The LAT is the escapement level below which dramatic declines in long-term productivity could occur. Since listing in 1999 as threatened under the ESA, annual fishery management for this stock has been for a ceiling exploitation rate rather than for a UMT or LAT escapement. The stock achieved the LAT in 2010.

#### 2.2.3.1.2 Skagit River Spring

The Skagit River drains into northern Puget Sound near Mount Vernon, and is the largest drainage basin in Puget Sound. The Skagit spring Chinook salmon stock includes early-timed populations returning to the Upper Sauk, Cascade, and Suiattle rivers.

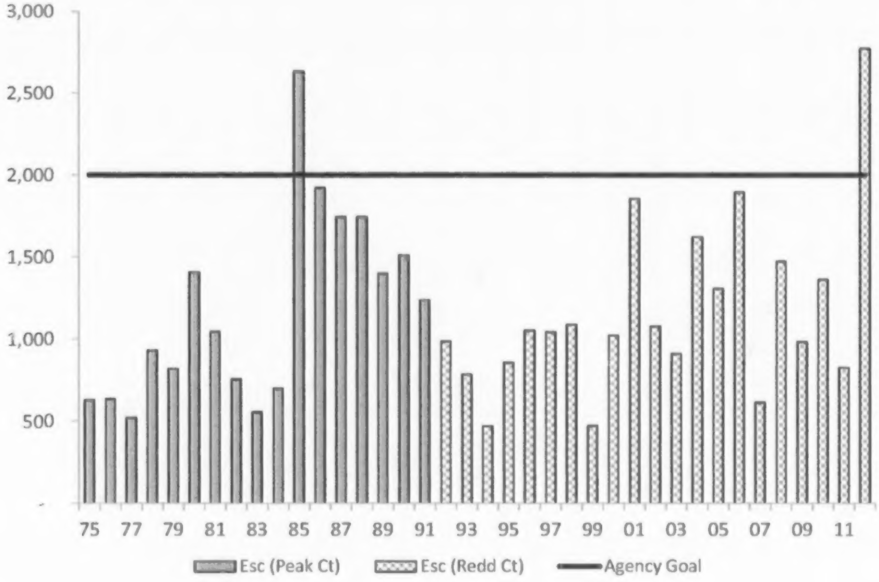


*Figure* 2.2.3.1.2.–*Skagit River escapement of spring Chinook salmon to the spawning grounds, 1975–2012.*

**Escapement Methodology:** Due to changes in spawning index areas, beginning in 1992 for the Cascade stock and 1994 for the Sauk and Suiattle stocks, escapements are not directly comparable to previous numbers. In the Upper Sauk, redds are counted from river mile 21.2 to 39.7 (Darrington to Forks), in the North Fork Sauk from the mouth to the falls, and in the South Fork Sauk (river mile 0 to 2.5). This method replaced the peak live and dead count approach in 1994. A redd life value of 30.2 days is used and is based on the average of a foot survey-based estimate of 22.9 days and an AUC back calculated estimate of 37.5 days. In the Cascade River, redds are counted in the mainstem upstream of river mile 7.8 and in the lower north fork and south fork, and Found, Kindy, and Sonny Boy creeks. Two helicopter flights and five foot surveys occurred over river mile 7.8 to 18.6. In the Suiattle basin, redds are counted in mainstem Suiattle, and in Big, Tenas, Straight, Circle, Buck, Lime, Downey, Sulphur, and Milk creeks. Prior to 1994, peak live and dead fish counts in Big, Tenas, Buck, and Sulphur creeks were used. Escapement may include very small numbers of hatchery strays in these natural production areas. Past PSC-funded studies on straying of Marblemount Hatchery spring Chinook salmon focused on the area immediately adjacent to the hatchery which is outside the survey reach for natural production. The 2012 escapement estimate was 2,774 natural spawners.

**Escapement Goal Basis:** There is currently no CTC-accepted escapement goal for this stock.

**Agency Comments:** The current UMT used by the state and tribal co-managers for the Skagit River spring Chinook salmon management unit is 2,000 with a LAT of 576 (CCMP 2010). Since listing in 1999 as threatened under the ESA, annual fishery management for this stock has been for a total exploitation rate ceiling rather than for a UMT or LAT escapement.

### 2.2.3.1.3 Skagit River Summer/Fall

The Skagit River summer/fall Chinook salmon stock includes the Upper Skagit summer, Sauk summer, and Lower Skagit fall run populations.

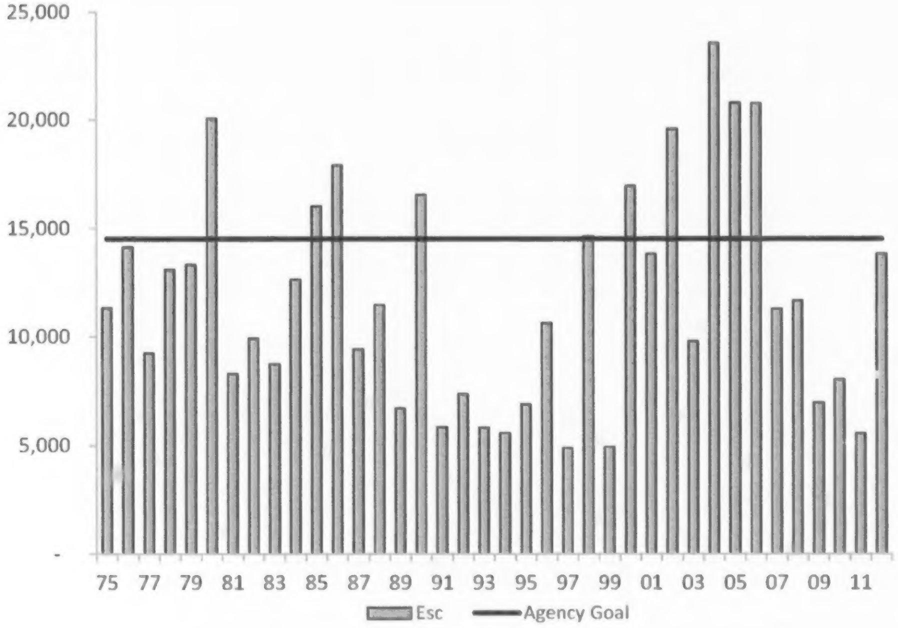


*Figure 2.2.3.1.3.–Skagit River escapement of summer/fall Chinook salmon to the spawning grounds, 1975–2012.*

**Escapement Methodology:** Escapement of Skagit summer/fall Chinook salmon was estimated using expansion of redd counts from helicopter surveys of mainstem areas and foot surveys of smaller tributaries. The counts are expanded by the AUC method (Smith and Castle 1994). This method assumes a 21-day redd life and 2.5 adult spawners for each estimated redd. The estimate is then reduced by 5% to account for "false" redds counted during aerial surveys. Natural escapement is predominantly offspring from natural-origin parent spawners; the remainder is hatchery origin fish from the wild stock tagging program that started in 1994. Natural escapement does not include the brood stock collected for this program. The 2012 escapement estimate was 13,817.

**Escapement Goal Basis:** There is currently no CTC-accepted escapement goal for this stock group.

**Agency Comments:** The UMT used by the state–tribal co-managers for the Skagit River summer/fall Chinook salmon management unit is 14,500, based on a recent assessment of freshwater productivity and accounting for variability and biases in management error (CCMP 2010). The LAT is 4,800 spawners. Since listing in 1999 as threatened under the ESA, annual fishery management for this stock has been for a total exploitation rate rather than for a UMT or LAT escapement. In years when the UMT is expected to be exceeded, terminal fisheries can be expanded subject to the overall ceiling exploitation rate.

### 2.2.3.1.4 Stillaguamish River

The Stillaguamish River drains into northern Puget Sound between Everett and Mount Vernon. The Stillaguamish River Chinook salmon stock includes a run of summer-timed Chinook salmon in the north fork of the Stillaguamish River and a much smaller number of fall fish in the south fork and mainstem of the Stillaguamish River.

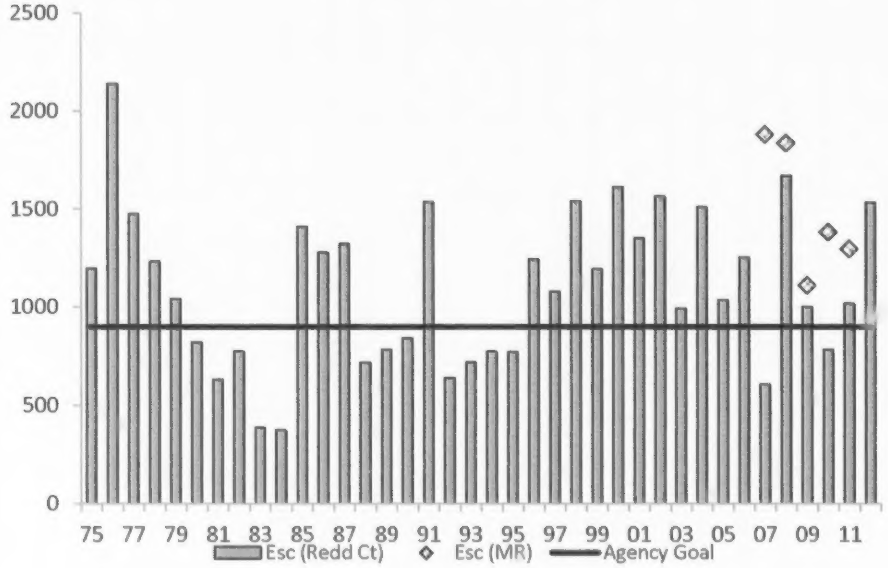


*Figure 2.2.3.1.4.–Stillaguamish River escapement of Chinook salmon to the spawning grounds, 1975–2012.*

**Escapement Methodology:** Escapement estimates for Stillaguamish Chinook salmon were based on redd count expansions, assuming a 21-day redd life. The north fork of the Stillaguamish River is surveyed more extensively, with one to three aerial surveys and AUC redd estimates. The escapement estimates for the south fork of the Stillaguamish River uses a peak redd count and assumes 2.5 fish per redd. Boulder and Squire creeks on the north fork of the Stillaguamish River and Jim Creek on the south fork of the Stillaguamish River are also surveyed.

Spawning escapement estimates of fall Chinook salmon may be biased low due to incomplete redd counts using visual sampling methods. Evidence of this is supported by MR studies in 2007 through 2010 funded through the SSP where escapement estimates were 1.1 times to 3.1 times higher than those from redd counts. Natural escapement excludes brood stock taken for the wild stock indicator program after 1987 but does include spawning hatchery fish from this production. Total natural spawning escapement in 2012 was estimated at 1,534 fish.

**Escapement Goal Basis:** There is currently no CTC-accepted escapement goal for this stock group.

**Agency Comments:** State–tribal co-managers have established a UMT for this management unit of 900 natural-origin spawners (600 from the north fork of the Stillaguamish River and 300 from the south fork of the Stillaguamish River and mainstem) with a LAT of 700 (CCMP 2010). The summer Chinook salmon supplementation program, which collects brood stock from the north fork of the Stillaguamish River return, was initiated in 1986 as a PST indicator stock program, and its current objective is to release 200,000 tagged fingerling smolts per year. Since 2000, an average of approximately 140 adults has been collected annually from the spawning population for this program. Most releases are into the north fork of the Stillaguamish River, via acclimation sites. Relatively small numbers of smolts have been released into the south fork of the Stillaguamish River. Since listing in 1999 as threatened under the ESA, annual fishery management for this stock has been for a ceiling exploitation rate rather than for a UMT or LAT escapement.

### 2.2.3.1.5 Snohomish River

The Snohomish River is located in northern Puget Sound near Everett. The Snohomish Chinook salmon stock includes the Skykomish and Snoqualmie summer/fall run populations. Skykomish Chinook salmon spawn in the mainstem of the Skykomish River, and its tributaries including the Wallace and Sultan rivers, in Bridal Veil Creek, the south fork of the Skykomish River between river mile 49.6 and river mile 51.1 and above Sunset Falls (fish have been transported around the falls since 1958), and the north fork of the Skykomish River up to Bear Creek Falls (river mile 13.1). Snoqualmie Chinook salmon spawn in the Snoqualmie River and its tributaries, including the Tolt River, Raging River, and Tokul Creek.

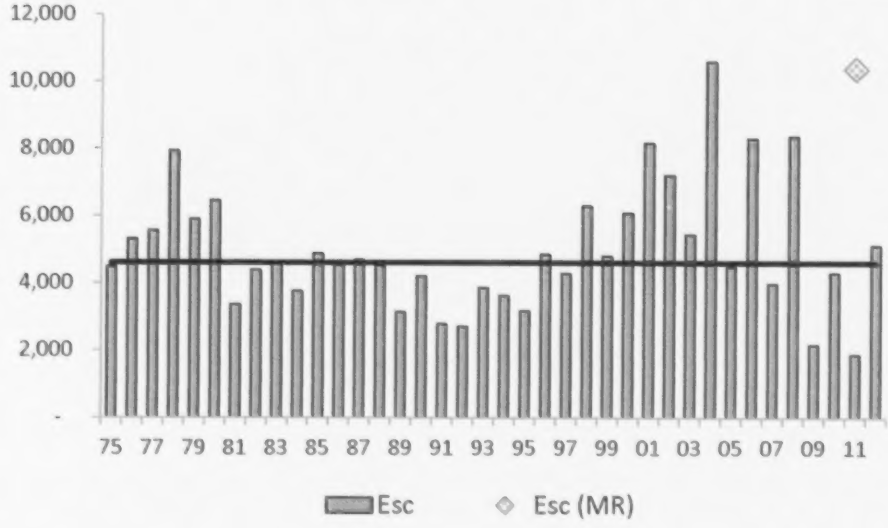


*Figure 2.2.3.1.5.–Snohomish River escapement of Chinook salmon to the spawning grounds, 1975–2012.*

**Escapement Methodology:** Escapement was estimated using expansion of redd counts conducted by a combination of helicopter, float, and foot surveys, and from fish counts at the Sunset Falls fishway. The natural escapement estimate includes a significant contribution of hatchery strays from the Wallace and Bernie Kai-Kai Gobin (Tulalip Tribe) facilities. A MR study funded under the SSP yielded an estimated spawning escapement of 10,399 for 2011 compared to the redd-based estimate of 1,880. The 2012 escapement was estimated at 5,123 natural spawners using redd counts.

**Escapement Goal Basis:** There is currently no CTC-accepted escapement goal for this stock.

**Agency Comments:** The state–tribal co-managers have a UMT for this stock of 4,600 natural-origin spawners (CCMP 2010). The LAT for Snohomish River summer/fall Chinook salmon is 2,800 fish. Since listing in 1999 as threatened under the ESA, annual fishery management for this stock has been for a ceiling exploitation rate rather than for a UMT or LAT escapement.

### 2.2.3.1.6 Lake Washington

The Lake Washington Chinook salmon stock includes the fall run populations in the Cedar River and in the North Lake Washington tributaries of Bear, Cottage, and Issaquah creeks. A hatchery is located on Issaquah Creek and Chinook salmon spawning in Issaquah Creek are not included in the natural escapement for Lake Washington.

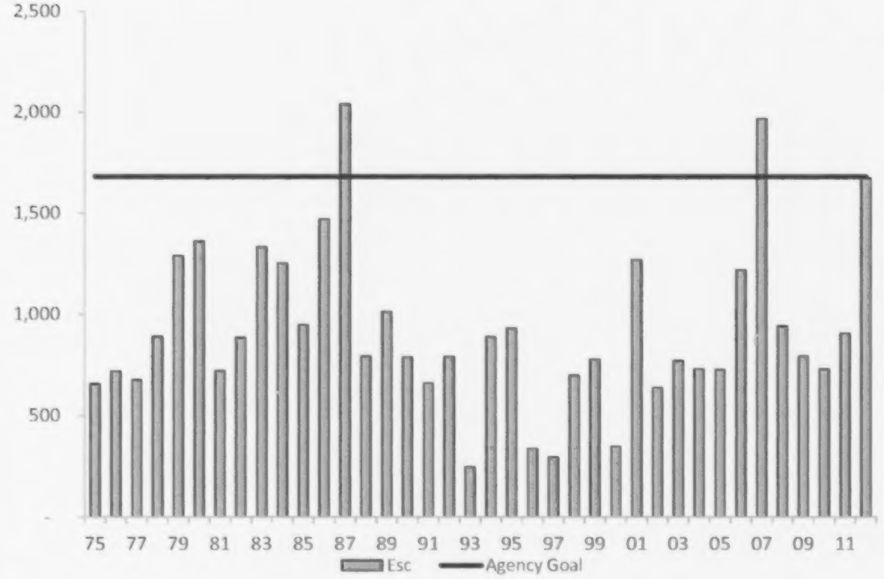


*Figure 2.2.3.1.6.–Escapement of Chinook salmon to the spawning grounds in the tributaries of Lake Washington (Cedar River and Bear and Cottage creeks), 1975–2012.*

**Escapement Methodology:** Natural spawners in Issaquah Creek that spawn below the Issaquah Hatchery are not included in the graph. It should be noted that although there are no hatchery fish released into the Cedar River, an average of 23% of the spawners from 2003 to 2008 were adipose clipped from mass-marked hatchery production, presumably from Issaquah Hatchery (CCMP 2010). Escapement in the Cedar River is estimated using expansion of total redd counts. In recent years, estimates of spawner abundance have also been made using redd counts performed over the entirety of the spawning area downstream of Landsburg Dam (CCMP 2010). These data were used to convert previous estimates of escapement within the index reach to estimates of spawner abundance (as would be derived through redd counts) for the entirety of the river (below the dam) using simple linear regression. Escapement to the North Lake Tributaries is estimated using live counts and AUC methods. The 2012 escapement for Lake Washington was 1,674 spawners, including 591 primarily hatchery origin fish in Bear and Cottage creeks.

**Escapement Goal Basis:** There is currently no CTC-accepted escapement goal for this stock.

**Agency Comments:** A state–tribal interim UMT escapement goal of 1,200 Chinook salmon for an index reach in the Cedar River was established in 1993 based on average escapements from 1965 to 1969. This goal for the index reach was converted to 1,680 Chinook salmon for the entirety of the river downstream of the dam and reflects a redd-based escapement value consistent with the interim escapement goal derived using AUC methodology. Since listing in 1999 as threatened under the ESA, annual fishery management for this stock has been for a ceiling exploitation rate rather than for a UMT or LAT escapement in the Cedar River; however, when the UMT is expected to be exceeded, some additional fishing in Lake Washington is considered.

### 2.2.3.1.7 Green River

The Green River Fall Chinook salmon stock consists of a single population spawning in the mainstem Green River and two of its major tributaries, Newaukum and Soos creeks.

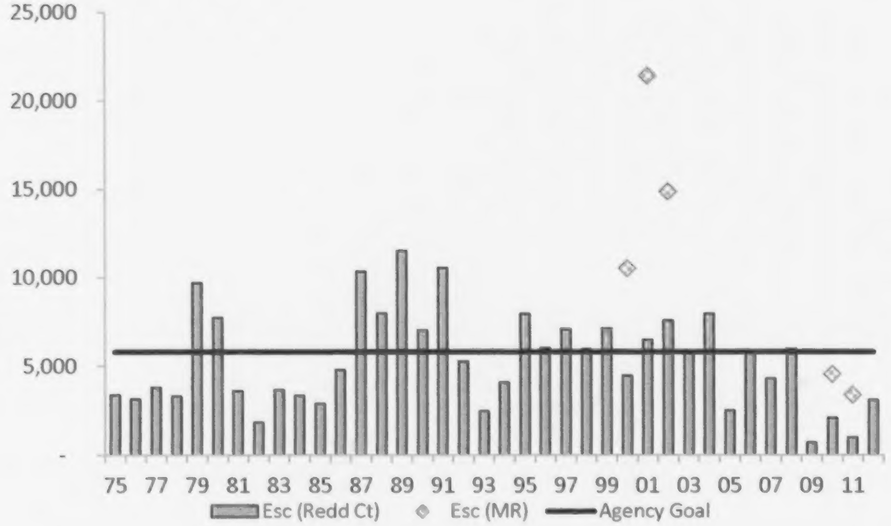


*Figure 2.2.3.1.7.–Green River escapement of Chinook salmon to the spawning grounds, 1975–2012.*

**Escapement Methodology**: Escapement is estimated from a redd count expansion method that has varied over the time series by the extent of spawning survey coverage. The method used until about 1996 involved an index area redd count multiplied by 2.6 to estimate total redds then multiplied by 2.5 fish per redd to produce estimated escapement. The 2.6 index to total redd expansion factor was based on a 1976 to 1977 U.S. Fish and Wildlife Service MR study. Since 1996, the survey areas have broadened and the associated expansion factor of 2.6 has been reduced to the point that the redd counts in 2009 have complete spawning reach coverage. The method used in recent years provides natural escapement estimates for the mainstem Green River and Newaukum Creek. Newaukum Creek redds are counted during foot surveys. The mainstem Green River is surveyed by boat and by air. Some parts of the river (i.e., the Gorge) are only surveyed by air. Boat surveys are generally done once a week, or twice a week in years with a large numbers of pink salmon. One aerial survey is made during the peak of spawning, more if budgets permit. Certain index reaches of the river are surveyed every week by boat to develop a cumulative redd count total for those reaches. These index reaches are distributed throughout the river. Visible redds are counted for the entire floatable part of the river by boat each week and for the entire river by helicopter during the peak. The ratio of visible redds seen by boat to those seen by air (boat surveys assumed to be best) is used to estimate how many redds would be seen by boat in the unfloated reaches. This provides an estimate of how many visible redds exist during the peak of spawning. To get from peak redds to cumulative total redds, the visible redds in the index reaches during the peak are compared to the season total for those index reaches. Different areas of the river have different ratios of peak visible redds to season totals. Expansion of non-index visible redds to season total redds uses the ratio from nearby index reaches of the same general character. The CTC considers these estimates from redd counts as index values rather than estimates of total escapement. Estimates of total escapement from MR studies in 2000, 2001, and 2002 funded through the U.S. Letter of Agreement were about 2.5 times higher than the escapement estimate from redd count expansion. In 2010 and 2011, the MR-based escapements from studies funded under the SSP were more than twice as high as the redd count expansion estimates. There is a large hatchery program in this basin and these fish comprise a large portion of the return. Hatchery fish contribution to the natural escapement ranged from 53% to 65% for the years 2004 to 2007. The escapement in 2012 from redd count expansion was 3,091 Chinook salmon of mixed hatchery and natural origin.

**Escapement Goal Basis:** There is currently no CTC-accepted escapement goal for this stock.

**Agency Comments:** The state–tribal UMT escapement goal of 5,800 naturally spawning adults is the average of the 1965 to 1976 escapements (Ames and Phinney 1977). The LAT is 1,800 fish. Since listing in 1999 as threatened under the ESA, annual fishery management for this stock has been on a ceiling exploitation rate in the southern U.S. pre-terminal fisheries and for the UMT in the terminal fisheries.

### 2.2.3.2 Coastal Washington

Coastal Washington stocks include spring, summer, and fall Chinook salmon from the Hoko, Quillayute, Hoh, and Queets rivers, and from Grays Harbor. Coastal Washington stocks have a northerly distribution and are vulnerable to southern U.S. fisheries primarily as mature fish during their spawning migrations. They are caught primarily in SEAK and NBC AABM fisheries and in terminal net fisheries.

#### 2.2.3.2.1 Hoko River

The Hoko River is located at the extreme western end of the Strait of Juan de Fuca and is not a population listed under the U.S. ESA as part of the Puget Sound Chinook Salmon Endangered Species Unit. Hoko River Chinook salmon spawn primarily in the mainstem of the Hoko River, with limited spawning in larger tributaries.

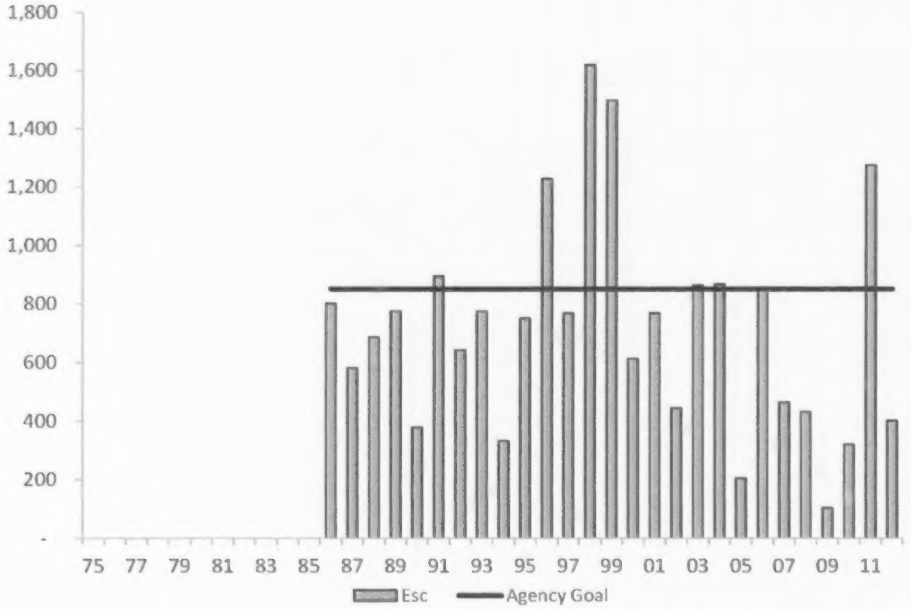


*Figure 2.2.3.2.1.–Hoko River escapement of Chinook salmon to the spawning grounds, 1986–2012.*

**Escapement Methodology:** The Makah Tribe and WDFW conduct ground surveys using cumulative redd counts for the mainstem (Hoko) and tributaries found between river mile 1.5 to 21.7, which represents the entire range of spawning habitat utilized by Chinook salmon. Redd counts are multiplied by 2.5 adults per redd. There are 10 mainstem reaches plus 13 tributary reaches, including Little Hoko, Browne's, Herman, NF Herman, Ellis, Bear, and Cub rivers, which are all upper mainstem tributaries. The tribe also surveys the mainstem Sekiu and Carpenter, SF Carpenter, Sunnybrook, and unnamed creeks 19.0215, 19.0216, and 19.0218. Escapement excludes brood stock collected from the spawning grounds for the supplementation program which started in 1988 and has collected an average of 149 fish annually through 2011. In 2012, 219 fish were retained for the supplementation program leaving a total natural spawning escapement estimate of 401 of mixed natural origin and returns from the supplementation program.

**Escapement Goal Basis:** There is currently no CTC-accepted escapement goal for this stock.

**Agency Comments:** The UMT escapement goal established by state and tribal co-managers is 850 naturally spawning adults. This goal was developed as a proxy for the spawning escapement for MSY. The escapement goal was calculated using a habitat based approach rather than a stock-recruitment analysis by estimating the amount of available spawning habitat, then expanded utilizing assumed optimal redds per mile and fish per redd values (Ames and Phinney 1977).

### 2.2.3.2.2 Quillayute River Summer

The Quillayute River drains from the northwest side of the Olympic Mountains into the Pacific Ocean, south of Cape Alava on the north Washington coast.

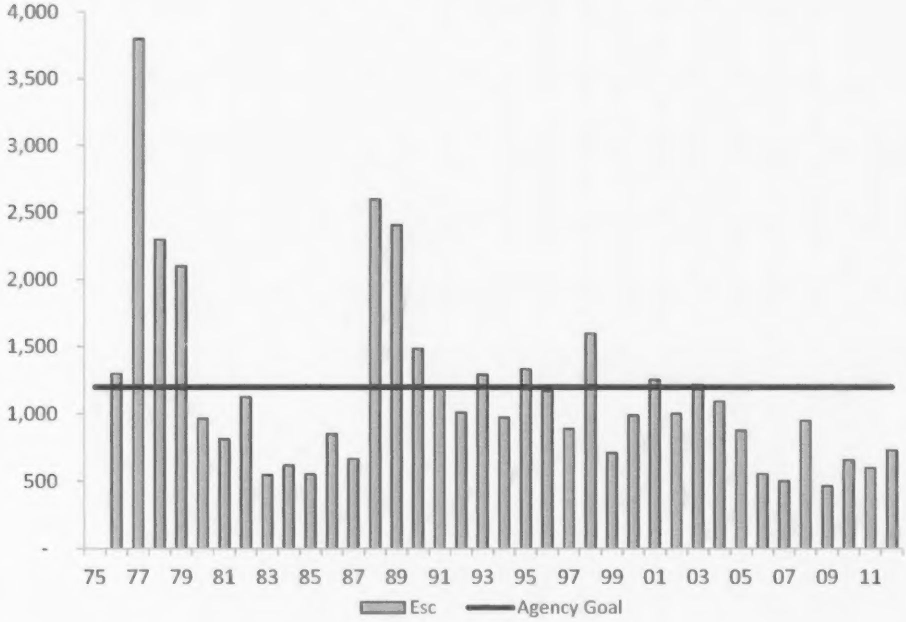


*Figure 2.2.3.2.2.–Quillayute River escapement of summer Chinook salmon to the spawning grounds, 1976–2012.*

**Escapement Methodology:** Escapement estimates are based on redd counts in index areas and from supplemental surveys on the Bogachiel, mainstem Calawah, North Fork Calawah and Sitkum rivers. This has been used consistently in the Quillayute River System since the 1970s. Surveys are conducted by foot, raft, drift boat and helicopter. Surveys in index areas are examined either weekly or bi-weekly as conditions allow. Supplemental surveys are done once a season during the peak spawning period. Redd counts from these supplemental surveys are then expanded by the index surveys to estimate redd construction within the supplemental survey areas for the entire season. Using an appropriate redds per mile assignment, the information from index and supplemental surveys is then applied to other streams and segments that have historically had fish presence, but were not surveyed. These areas comprise the Quillayute River system "stream mileage base" that is consistently calculated to estimate escapement numbers. The number of redds is multiplied by 2.5 to estimate fish escapement. The 2012 escapement estimate for summer Chinook salmon was 731.

**Escapement Goal Basis:** There is currently no CTC-accepted escapement goal for this stock.

**Agency Comments:** The state–tribal management goal for this stock is 1,200 adults and jacks combined (PFMC 2003).

#### 2.2.3.2.3 Quillayute River Fall

The Quillayute River drains from the northwest side of the Olympic Mountains into the Pacific Ocean, south of Cape Alava on the north Washington coast. It is one of three Washington coast river systems that contain fall Chinook salmon with CTC-approved escapement goals.

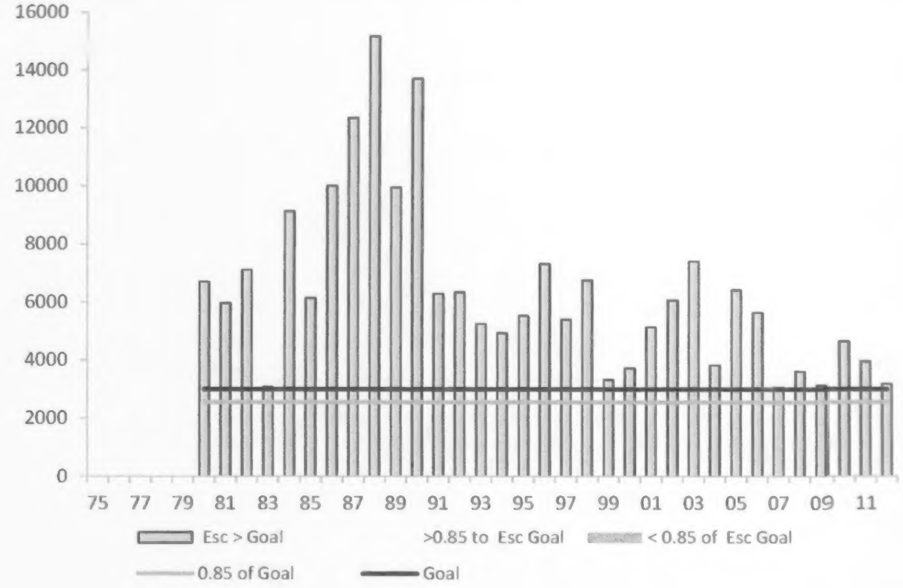


*Figure 2.2.3.2.3.–Quillayute River escapement of fall Chinook salmon to the spawning grounds, 1980–2012.*

**Escapement Methodology:** Escapement estimates are based on redd counts in index areas and from supplemental surveys on the Bogachiel, Sol Duc, Dickey, Calawah rivers and several other smaller tributaries in the basin. This has been used consistently in the Quillayute River System since the 1970s. Surveys are conducted by foot, raft, drift boat and helicopter. Surveys in index areas are examined either weekly or bi-weekly as conditions allow. Supplemental surveys are done once a season during the peak spawning period. Redd counts from these supplemental surveys are then expanded by the index surveys to estimate redd construction within the supplemental survey areas for the entire season. Using an appropriate redds per mile assignment, the information from index and supplemental surveys is then applied to other streams and segments that have historically had fish presence, but were not surveyed. These areas comprise the Quillayute River system "stream mileage base" that is consistently calculated to estimate escapement numbers. The number of redds is multiplied by 2.5 to estimate fish escapement. The 2012 escapement estimate was 3,181.

**Escapement Goal Basis:** In 2004, the CTC-approved an escapement goal for Quillayute fall Chinook salmon of 3,000 natural spawners based on a spawner–recruit analysis developed by Cooney (1984) and QDNR (1982).

**Agency Comments:** Terminal fisheries are managed for a harvest rate of 40%, with an escapement floor of 3,000 fish (PFMC 2003). This objective is designed to actively probe at and above estimates of escapements that produce MSH, while minimizing potential detrimental effects of existing fisheries. Stock production analyses of spawning escapements from 1968 to 1982 were used to determine the initial escapement floor.

### 2.2.3.2.4 Hoh River Spring/Summer

The Hoh River drains from the western side of the Olympic Mountains on the north Washington coast between the Quillayute River to the north and the Queets River to the south.

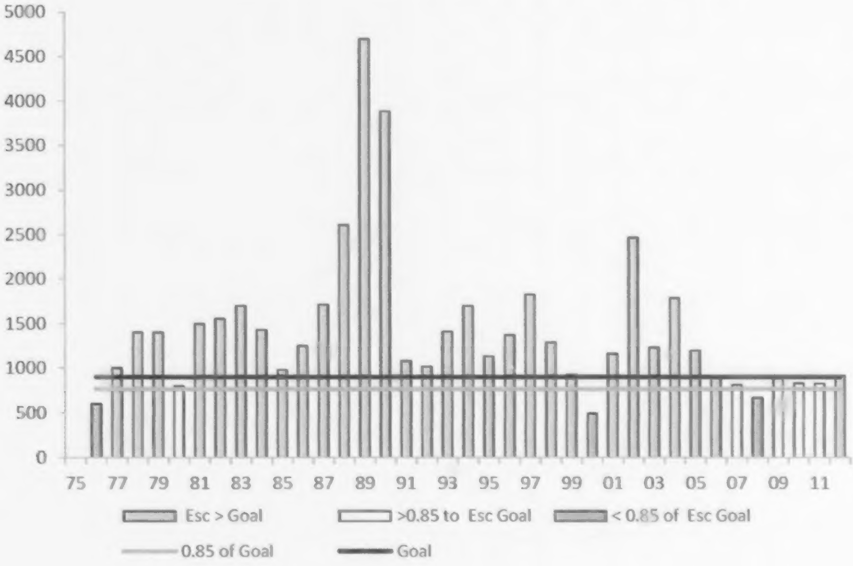


*Figure 2.2.3.2.4.–Hoh River escapement of spring/summer Chinook salmon to the spawning grounds, 1976–2012.*

**Escapement Methodology:** Escapement is estimated from redd counts in index areas and supplemental surveys in the mainstem and south fork of the Hoh River and in tributaries with spawning habitat. Surveys are conducted by foot, boat, and helicopter. Intensively monitored index reaches are surveyed each week where surveyors record new and visible redds. Cumulative redd counts for each index reach represents the total spawner abundance for that particular spawning area. Weekly visible redd counts in index reaches are used to estimate spawning timing curves by calculating the proportion of season cumulative redds that are visible on each weekly survey date. Surveys are also conducted in reaches too large or remote to intensively monitor throughout the season. These surveys are timed as close as possible to peak spawning activity and spawner abundance estimates are derived using index timing curves. For areas with suitable habitat but not regularly surveyed, redd densities (cumulative redds per river mile) from surveyed reaches with similar habitat type are used to estimate escapement into these reaches of known stream length. The total natural spawning escapement is calculated assuming 2.5 fish per redd. There is no hatchery program in this system The 2012 natural escapement estimate was 915 fish.

**Escapement Goal Basis:** Escapement floor policy of 900 for the Hoh spring/summer Chinook salmon was developed by Cooney (1984) and QDNR (1982), based on spawner–recruit analyses, and was accepted by the CTC in 2004.

**Agency Comments:** Similar to many of the other Washington coastal stocks, Hoh River spring/summer escapements have been relatively stable except for much larger returns in 1988, 1989, and 1990. The terminal return for this stock declined from 1997 to 2000, had rebounded in 2001 before declining again since 2005. Terminal fisheries are managed to catch 31% of the river run, with an escapement floor of 900 fish (PFMC 2003). This objective is designed to allow a wide range of spawner escapements from which to eventually develop an MSY objective or proxy while protecting the long-term productivity of the stock. Stock production analysis of spawning escapement for brood years 1969 to 1976 was utilized to determine the initial escapement floor.

### 2.2.3.2.5 Hoh River Fall

The Hoh River drains from the western side of the Olympic Mountains on the north Washington coast between the Quillayute River to the north and the Queets River to the south. It is one of three Washington coast river systems that contain fall Chinook salmon with CTC-approved escapement goals.

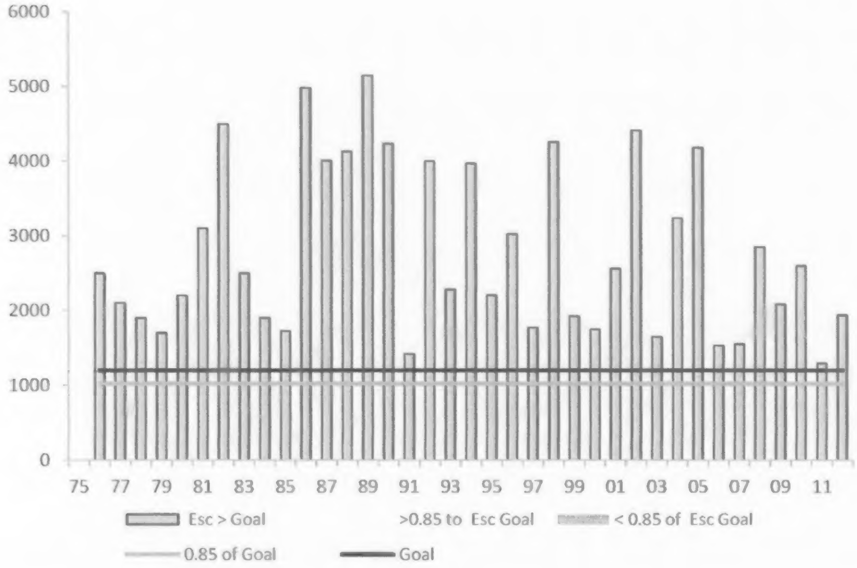


*Figure 2.2.3.2.5.–Hoh River escapement of fall Chinook salmon to the spawning grounds, 1976–2012.*

**Escapement Methodology:** Escapement is estimated from redd counts in index areas and supplemental surveys in the mainstem and south fork Hoh River and in tributaries with spawning habitat. Surveys are conducted by foot, boat, and helicopter. Intensively monitored index reaches are surveyed each week where surveyors record total new and visible redds observed each week. Cumulative redd counts for each index reach represents the total spawner abundance for that particular spawning area. Weekly visible redd counts in index reaches are used to estimate spawning timing curves by calculating the proportion of season cumulative redds that are visible on each weekly survey date. Extensive surveys are also conducted in non-intensively monitored stream areas utilized by spawning Chinook salmon. These extensive reaches encompass areas too large or remote to intensively monitor throughout the season. Extensive surveys are timed as close as possible to peak spawning activity. Extensive reach spawner abundance estimates are derived using index timing curves. For areas with suitable habitat but not regularly surveyed, redd densities (cumulative redds per river mile) from surveyed reaches with similar habitat type are used to estimate escapement into these reaches of known stream length. The total natural spawning escapement is calculated assuming 2.5 fish per redd. The natural escapement estimates for Hoh River fall Chinook salmon include a small number of fish taken for an experimental hatchery program from 1983 to 1986, but otherwise should be considered natural-origin fish. The 2012 escapement estimate was 1,937 fish.

**Escapement Goal Basis:** The escapement floor of 1,200 for the Hoh fall Chinook salmon was developed by Cooney (1984) and QDNR (1982), based on spawner–recruit analyses, and was accepted by the CTC in 2004 as the escapement goal.

**Agency Comments:** The state–tribal management plan for this stock includes a harvest rate of 40% of the terminal run, with an escapement floor of 1,200 spawners (PFMC 2003). This objective is designed to actively probe at and above estimates of the escapements that produce MSH, while minimizing potential detrimental effects of existing fisheries. Stock production analyses of spawning escapements from 1968 to 1982 were utilized to determine the initial escapement floor.

#### 2.2.3.2.6 Queets River Spring/Summer

The Queets River drains from the western side of the Olympic Mountains on the north Washington coast and is south of the Hoh River.

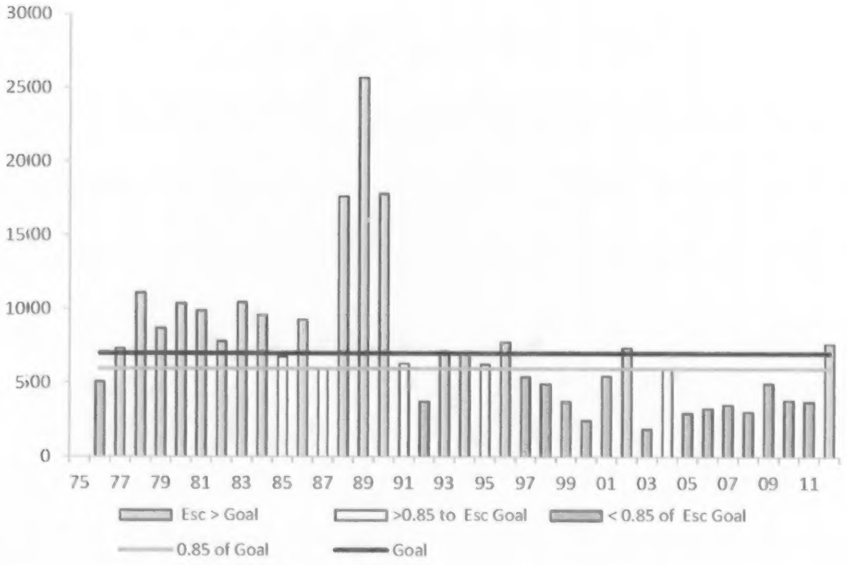


*Figure 2.2.3.2.6.–Queets River escapement of spring/summer Chinook salmon to the spawning grounds, 1976–2012.*

**Escapement Methodology:** Escapement is estimated from redd counts from August 15 to October 15 for spring/summer Chinook salmon. Surveys are conducted by foot, boat, and helicopter. Intensively monitored index reaches are surveyed each week where surveyors record total new and visible redds observed each week. Cumulative redd counts for each index reach represents the total spawner abundance for that particular spawning area. Weekly visible redd counts in index reaches are used to estimate spawning timing curves by calculating the proportion of season cumulative redds that are visible on each weekly survey date. Extensive surveys are also conducted in non-intensively monitored stream areas utilized by spawning Chinook salmon. These extensive reaches encompass areas too large or remote to intensively monitor throughout the season. Extensive surveys are timed as close as possible to peak spawning activity. Extensive reach spawner abundance estimates are derived using index timing curves. For areas with suitable habitat but not regularly surveyed, redd densities (cumulative redds per river mile) from surveyed reaches with similar habitat type are used to estimate escapement into these reaches of known stream length. The total natural spawning escapement is calculated assuming 2.5 fish per redd. The 2012 estimate of natural escapement was 764.

**Escapement Goal Basis:** Escapement floor policy of 700 for Queets spring/summer Chinook salmon was developed by Cooney (1984) and QDNR (1982), based on spawner–recruit analyses, and was accepted by the CTC in 2004 as the escapement goal. Stock production analysis of spawning escapements for brood years 1969 to 1976 were used to determine the initial escapement floor.

**Agency Comments:** Terminal fisheries are managed by the state and tribes to catch 30% of the river run size, with an escapement floor of 700 fish (PFMC 2003). This objective is designed to actively probe at and above the estimates of escapement that produce MSH. Since 1990, terminal fisheries have had minimal impact on this stock as returns to the river have rarely exceeded the escapement floor. Since 2000, sport anglers have been required to release all Chinook salmon during the summer, and tribal fisheries have been limited to one tribal netting day for ceremonial and subsistence purposes.

#### 2.2.3.2.7 Queets River Fall

The Queets River drains from the western side of the Olympic Mountains on the north Washington coast and is south of the Hoh River. It is one of three Washington coast river systems that contain fall Chinook salmon with CTC-approved escapement goals.

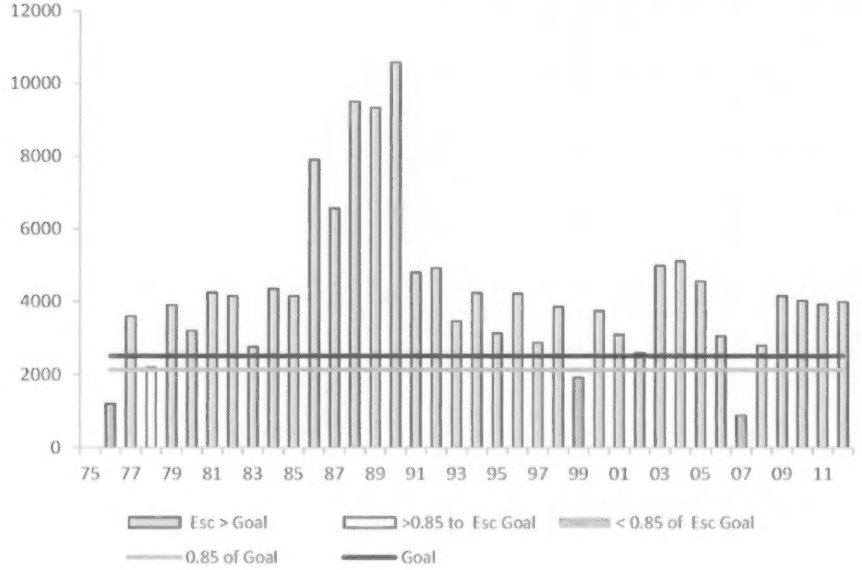


*Figure 2.2.3.2.7.–Queets River escapement of fall Chinook salmon to the spawning grounds, 1976–2012.*

**Escapement Methodology:** Escapement is estimated from redd counts from October 15 to December 1 for fall Chinook salmon. Surveys are conducted by foot, boat, and helicopter. Intensively monitored index reaches are surveyed each week where surveyors record total new and visible redds observed. Cumulative redd counts for each index reach represents the total spawner abundance for that particular spawning area. Weekly visible redd counts in index reaches are used to estimate spawning timing curves by calculating the proportion of season cumulative redds that are visible on each weekly survey date. Extensive surveys are also conducted in non-intensively monitored stream areas utilized by spawning Chinook salmon. These extensive reaches encompass areas too large or remote to intensively monitor throughout the season. Extensive surveys are timed as close as possible to peak spawning activity. Extensive reach spawner abundance estimates are derived using index timing curves. For areas with suitable habitat but not regularly surveyed, redd densities (cumulative redds per river mile) from surveyed reaches with similar habitat type are used to estimate escapement into these reaches of known stream length. The total natural spawning escapement is calculated assuming 2.5 fish per redd. The natural escapement of Queets River fall Chinook salmon was 3,993 in 2012.

**Escapement Goal Basis:** The escapement floor policy of 2,500 for the Queets fall Chinook salmon was developed by Cooney (1984) and QDNR (1982), and was based on spawner–recruit analyses, and was accepted by the CTC in 2004 as the escapement goal.

**Agency Comments:** Terminal fisheries are managed by the state and tribes to catch 40% of the river return, with an escapement floor of 2,500 spawners (PFMC 2003). This objective is designed to actively probe at and above estimates of the escapements that produce MSH. Stock production analyses of spawning escapements from 1967 to 1982 were used to determine the initial escapement floor.

### 2.2.3.2.8 Grays Harbor Spring

Grays Harbor spring Chinook salmon spawn primarily in the upper reaches of mainstem Chehalis River and its tributaries.

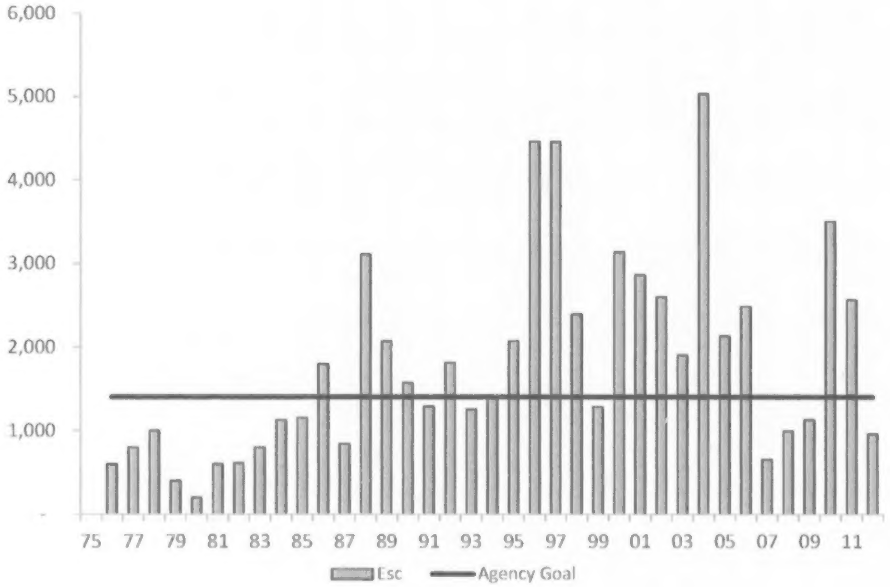


*Figure 2.2.3.2.8.–Grays Harbor escapement of spring Chinook salmon to the spawning grounds, 1976–2012.*

**Escapement Methodology:** Escapement is estimated by redd counts from August 15 to October 15 for spring/summer Chinook salmon. Surveys are conducted by foot, boat, and helicopter. Intensively monitored index reaches are surveyed each week where surveyors record total new and visible redds observed. Cumulative redd counts for each index reach represents the total spawner abundance for that particular spawning area. Weekly visible redd counts in index reaches are used to estimate spawning timing curves by calculating the proportion of season cumulative redds that are visible on each weekly survey date. Extensive surveys are also conducted in non-intensively monitored stream areas utilized by spawning Chinook salmon. These extensive reaches encompass areas too large or remote to intensively monitor throughout the season. Extensive surveys are timed as close as possible to peak spawning activity. Extensive reach spawner abundance estimates are derived using index timing curves. For areas with suitable habitat but not regularly surveyed, redd densities (cumulative redds per river mile) from surveyed reaches with similar habitat type are used to estimate escapement into these reaches of known stream length. The total natural spawning escapement is calculated assuming 2.5 fish per redd. The 2012 escapement was 959 Chinook salmon.

**Escapement Goal Basis:** There is currently no CTC-accepted escapement goal for this stock group.

**Agency Comments:** The natural spawning escapement goal established by the state–tribal co-managers for Grays Harbor spring Chinook salmon is 1,400 adult fish (PFMC 2003). This single targeted goal was developed as a MSY proxy. This objective was derived from actual spawning data from the mid- to late 1970s, and expanded to include additional habitat not covered by spawner surveys.

#### 2.2.3.2.9 Grays Harbor Fall

Grays Harbor fall Chinook salmon spawn primarily in the mainstem Chehalis River, in the Humptulips River and Satsop rivers where fall Chinook salmon hatchery facilities are located and in smaller tributaries such as the Wishkah and Hoquiam rivers that flow directly into the harbor.

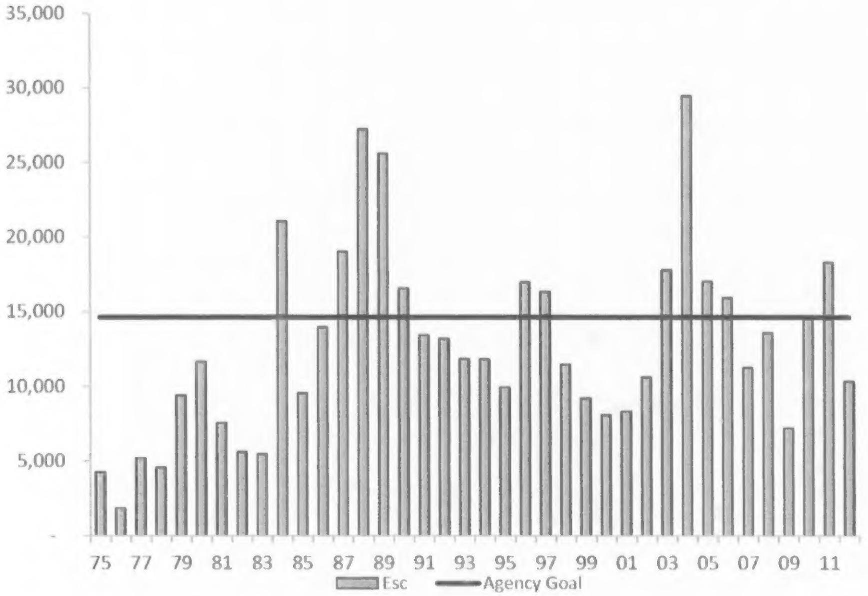


*Figure 2.2.3.2.9.–Grays Harbor escapement of fall Chinook salmon to the spawning grounds, 1976–2012.*

**Escapement Methodology:** Escapement is estimated from redd counts from October 15 to December 1 for fall Chinook salmon. Surveys are conducted by foot, boat, and helicopter. Intensively monitored index reaches are surveyed each week where surveyors record total new and visible redds observed. Cumulative redd counts for each index reach represents the total spawner abundance for that particular spawning area. Weekly visible redd counts in index reaches are used to estimate spawning timing curves by calculating the proportion of season cumulative redds that are visible on each weekly survey date. Extensive surveys are also conducted in non-intensively monitored stream areas utilized by spawning Chinook salmon. These extensive reaches encompass areas too large or remote to intensively monitor throughout the season. Extensive surveys are timed as close as possible to peak spawning activity. Extensive reach spawner abundance estimates are derived using index timing curves. For areas with suitable habitat but not regularly surveyed, redd densities (cumulative redds per river mile) from surveyed reaches with similar habitat type are used to estimate escapement into these reaches of known stream length. The total natural spawning escapement is calculated assuming 2.5 fish per redd. The 2012 escapement was 10,341 spawners.

**Escapement Goal Basis:** There is currently no CTC-accepted escapement goal for this stock group.

**Agency Comments:** The state–tribal escapement goal for Grays Harbor fall Chinook salmon is 14,600 spawners to the combined Chehalis and Humptulips rivers (PFMC 2003). This single targeted goal was developed as an MSY proxy. The objective represents assumed optimal spawner density based on estimated available habitat.

### 2.2.3.3 *Columbia River*

Columbia River stocks include spring, summer, and fall Chinook salmon from the Columbia River and its tributaries. Runs may have markedly different marine distributions with different vulnerabilities to ocean fisheries. Upriver spring stocks generally migrate offshore and are rarely retained in ocean salmon fisheries. As a result, they are not identified as a PSC escapement indicator stock in Attachments I–V of the PST. Most summer and fall stocks have a northern distribution. Lower Columbia River tule fall Chinook salmon have a more local distribution and are caught mainly in the WCVI AABM fishery and U.S. ISBM fisheries.

#### 2.2.3.3.1 Columbia Upriver Spring

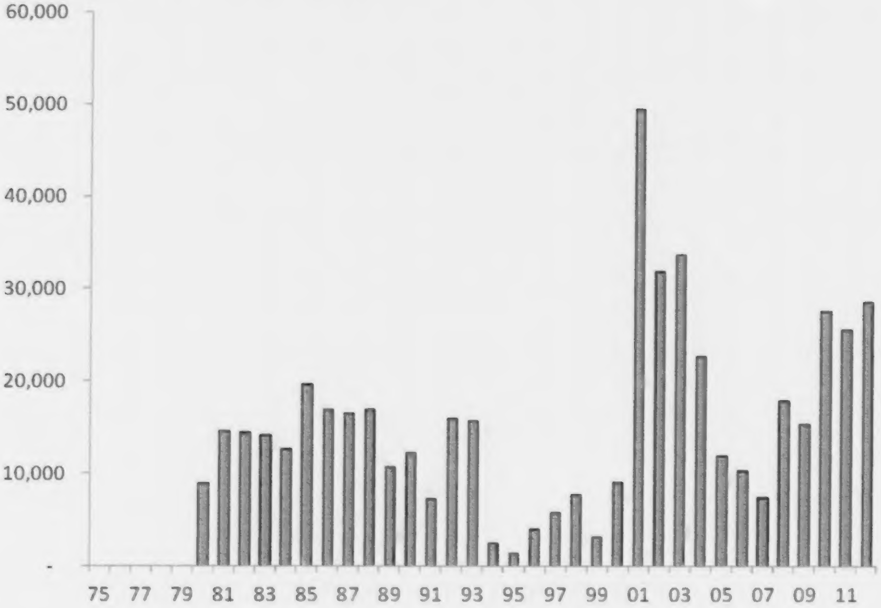


*Figure 2.2.3.3.1.–Columbia upriver escapement of spring Chinook salmon, 1980–2012.*

**Escapement Methodology:** Historically, the spring run through Bonneville Dam was assessed through June 1. Following ESA listing of Snake River spring/summer Chinook salmon, the spring management period was extended to June 15 so the listed stock could be managed under more restrictive catch rates. In previous CTC reports, graphed escapements were Bonneville Dam count minus total fishery mortalities above Bonneville Dam, multiplied by a complicated estimate of the proportion at Bonneville of fish not subsequently caught that didn't return to hatcheries, i.e., proportion wild. To simplify and provide consistency with the Technical Advisory Committee's annual Joint Staffs Reports (Joint Columbia River Management Staff, 2013, Tables 8 and 9), future graphs will simply provide the sum of wild adult upper Columbia spring Chinook salmon passing Rock Island Dam and wild adult Snake River spring/summer Chinook salmon passing Lower Granite Dam (plus Tucannon escapements below), recognizing that for purposes of fishery management and allocation, Columbia Upriver spring stock includes all (hatchery and wild) fish destined to return past Bonneville during the spring management period and there are also additional tributary spawning escapements (e.g., Deschutes and John Day rivers) that comprise the Columbia Upriver spring management unit. This times series should provide a more consistent and easily attained index of the abundance trend of naturally spawning fish, although it is not a completely comprehensive estimate of the naturally spawning fraction of Columbia Upriver spring Chinook salmon escapement past Bonneville.

**Escapement Goal Basis:** Under the 1988 Columbia River Fisheries Management Plan (CRFMP 1988), the interim management goal was 115,000 hatchery and wild adult Chinook salmon counted at Bonneville Dam and 25,000 naturally produced plus 10,000 hatchery-produced adults counted at Lower Granite Dam (CRFMP 1988). Under the 2008–2017 *U.S. v. Oregon* Management Agreement (MA), this stock is not managed for an escapement goal. Fishery impacts are managed using harvest rate schedules based on total river mouth abundance of upriver spring Chinook salmon or the Snake River natural spring/summer run size if it is less than 10% of the total run size (2008–2017 *U.S. v. Oregon* MA, Table A1).

**Agency Comments:** The 2008–2017 *U.S. v. Oregon* MA provides for a minimum annual mainstem treaty Indian Ceremonial and Subsistence entitlement of 10,000 spring and summer Chinook salmon. Beginning in 2010, modifications to Table A1 (2008–2017 *U.S. v. Oregon* MA) were implemented requiring non-Indian fisheries to meet catch balance provisions in the MA for upriver spring Chinook salmon. Under these provisions, non-Indian fisheries are managed to remain within ESA impacts, and to not exceed the total allowable catch available for treaty fisheries.

#### 2.2.3.3.2 Columbia Upriver Summer

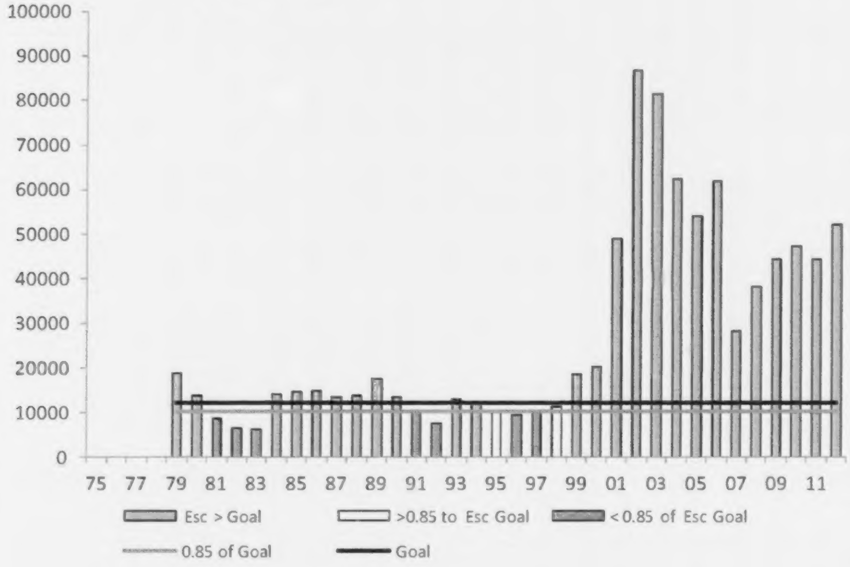


*Figure 2.2.3.3.2.–Columbia upriver summer Chinook salmon escapements, 1979–2012.*

**Escapement Methodology:** Graphed escapements are Rock Island Dam counts of all adult summer Chinook salmon, for compatibility with the interim escapement goal.

**Escapement Goal Basis:** The CTC (1999) developed an interim escapement goal of 12,143 summer Chinook salmon past Rock Island Dam, based on PSC Chinook salmon model data. Because model data used to develop the escapement goal included both hatchery and wild fish, the goal is not directly comparable to naturally spawning escapement estimates above Rock Island Dam. A revised analysis in 2008 using actual escapement data resulted in a similar goal, but modifications to the analysis were requested by the CTC and no action was taken.

**Agency Comments:** Columbia upriver summer Chinook salmon fisheries occur from June 16 to July 31, according to a catch rate schedule based on expected river mouth abundance. The schedule is provided in Table A2 of the 2008–2017 *U.S. v. Oregon* MA. In addition, Columbia upriver summer Chinook salmon are managed for a goal of 29,000 hatchery and natural-origin adults, as measured at the Columbia River mouth. This management goal is based on an interim combined spawning escapement goal of 20,000 hatchery and natural adults, including the following three components: 13,500 Wenatchee/Entiat/Chelan natural fish, 3,500 Methow/Okanogan natural fish and 3,000 hatchery fish.

#### 2.2.3.3.3 Columbia Upriver Bright

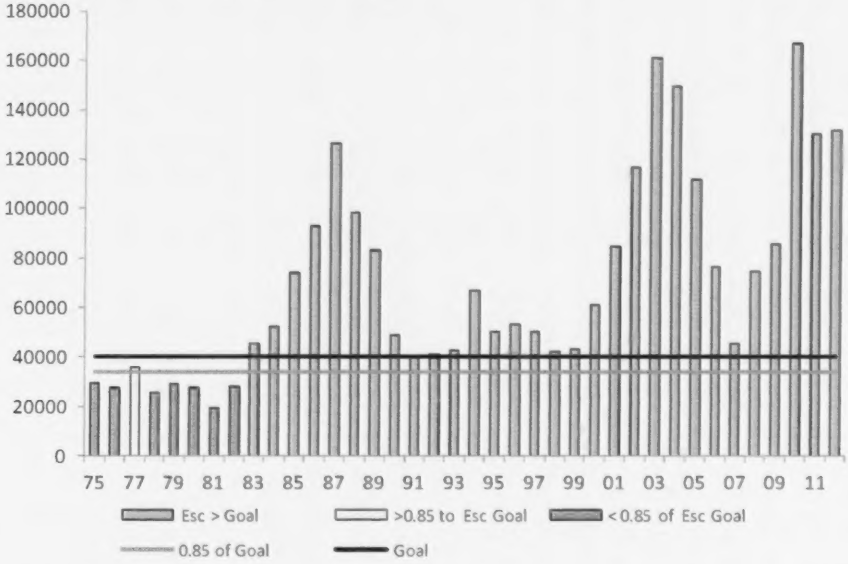


*Figure 2.2.3.3.3.–Columbia Upriver escapement of bright Chinook salmon, 1975–2012.*

**Escapement Methodology:** Escapement estimates are calculated as the McNary Dam count minus Hanford Reach adult sport catch, minus brood stock taken by Priest Rapids, Ringold and Snake River hatcheries.

**Escapement Goal Basis:** The CTC agreed escapement goal for Columbia Upriver bright Chinook salmon is 40,000 naturally spawning fish past McNary Dam based on stock-recruitment analyses.

**Agency Comments:** Under the 2008–2017 *U.S. v. Oregon* MA, the minimum combined Columbia River and Snake River upriver bright management goal at McNary Dam is 60,000 adult fall Chinook salmon, which includes both hatchery and natural production for all areas above McNary Dam. The Parties also agreed to 43,500 as the minimum Upriver bright adult escapement to meet the combined Hanford Reach, Lower Yakima River, and mainstem Columbia River above Priest Rapids Dam natural spawning goal, as well as the current Priest Rapids Hatchery production (this historically included a minimal run to the Snake River).

### 2.2.3.3.4 Deschutes River

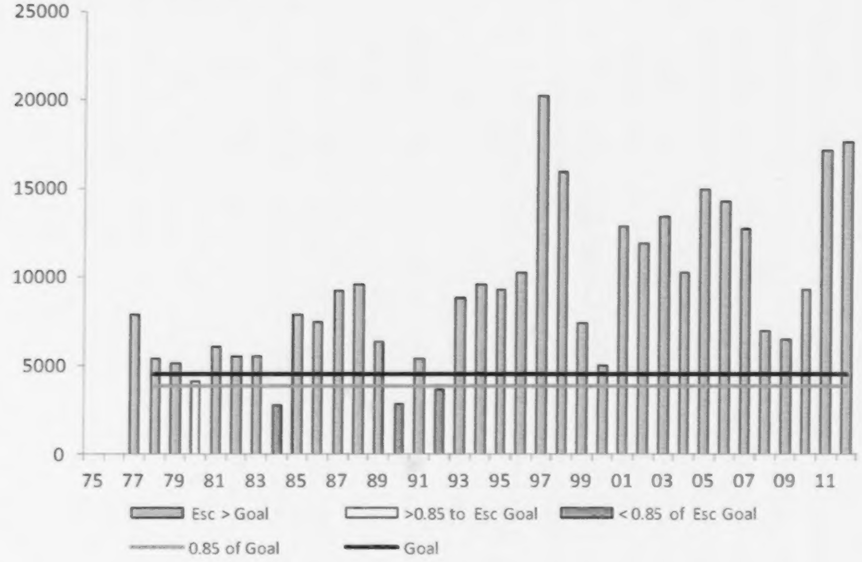


*Figure 2.2.3.3.4.–Deschutes River escapements of fall Chinook salmon, 1977–2012.*

**Escapement Methodology:** Escapement data are based on a MR estimate for the area above Sherars Falls and expanded for redd counts below Sherars Falls. From 2000 through 2007, Confederated Tribes of the Warm Springs Reservation of Oregon performed an entire river MR experiment to validate the Deschutes River fall Chinook salmon escapement estimates. Results of these MR studies confirm the validity of the historical estimation methodology. For historic years where the entire river was not surveyed for redd counts, the time series was updated based on a comprehensive analysis done by Warm Springs, Oregon Department of Fish and Wildlife (ODFW) and Columbia River Intertribal Fish Commission (CRITFC) staff.[2] An escapement goal was derived from the updated time series and approved by the CTC. The metric reported above is the ODFW MR estimate based on expanding the Sherars Falls MR estimate for redds below Sherars Falls.

**Escapement Goal Basis:** The CTC-agreed escapement goal for Deschutes River fall Chinook salmon is 4,532 fish.[2]

**Agency Comments:** Deschutes River fall Chinook salmon escapements have been maintained above the goal since 1992.

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[2] Sharma, R, J. Seals, J. Graham, E. Clemons, H. Yuen, M. McClure, K. Kostow, and S. Ellis. 2010. Deschutes River Chinook spawner escapement goal using U.S. v. Oregon Technical Advisory Committee data. Unpublished Report.

#### 2.2.3.3.5 Lewis River

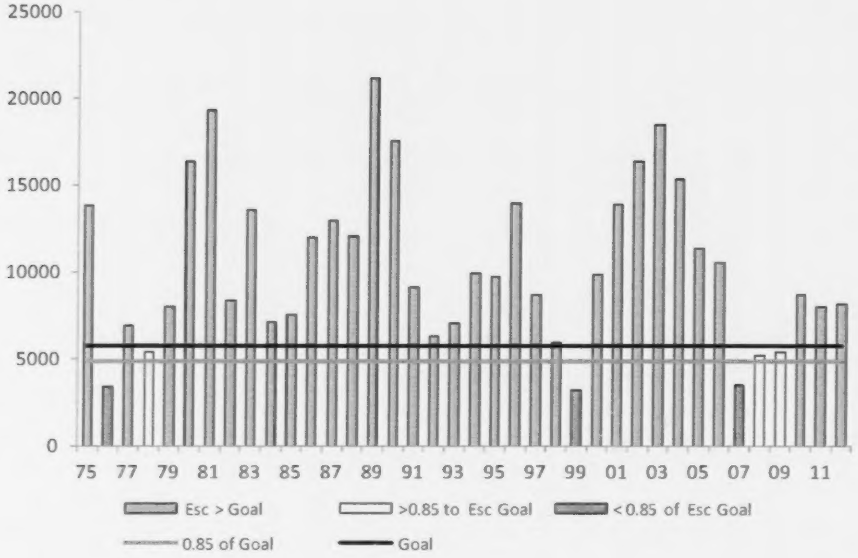

*Figure 2.2.3.3.5.–Lewis River escapements of fall Chinook salmon, 1975–2012.*

**Escapement Methodology:** Most natural bright fall Chinook salmon production below Bonneville Dam occurs in the North Fork Lewis River. The Lewis River Wild stock is the main component of the Lower River Wild management unit for fall Chinook salmon, which also includes small amounts of wild production from the Cowlitz and Sandy river basins. In this report, the escapements and goal are for the Lewis River component. Annual escapement estimates are obtained by expanding peak counts from weekly counts of live and dead fish in the 6.4 km area below Merwin Dam (river km 31.4) by a factor of 5.29 (total spawners/peak count).This factor was derived from a carcass tagging and recapture study performed in 1976 (McIsaac 1990). From 1999 to 2001, an Letter of Agreement funded study estimated and verified the expansion factor. A CWT program for wild fish has been in place since the 1977 brood. Methods of CWT recovery, escapement counting, and expansion of the index area fish counts have been consistent since 1964. All naturally spawning adult fish, both from hatchery and natural production, are included in the escapement.

**Escapement Goal Basis:** The escapement goal of 5,700 fall Chinook salmon in the Lewis River was developed by McIsaac (1990), based on spawner–recruit analysis of the 1964 to 1982 broods and CWT recoveries from the 1977 to 1979 broods. This analysis was updated by the CTC (1999) using brood years 1964 to 1991 and the goal of 5,700 was accepted as a biologically-based goal.

**Agency Comments:** Lewis River escapements have been above their escapement goal since 1979, with the exception of 1999 and 2007 through 2009.

### 2.2.3.4 *Coastal Oregon*

#### 2.2.3.4.1 Oregon Coastal North Migrating

The predominance of Chinook salmon production in the NOC occurs from naturally produced, fall-returning, ocean-type life histories of fish. The largest age classes which normally contribute to spawning escapement are 4- and 5-year-old adult fish; however, there are smaller proportions of spawning escapement that are observed each return year that are both 3- and 6-year-old fish. These Chinook salmon are caught primarily in SEAK, NBC and terminal fisheries.

Currently, only NOC fall Chinook salmon are accounted for in PSC management, while work is underway to include MOC production into the auspices of the PSC regime. The NOC production is bounded by the Necanicum on the north through the Siuslaw Basin on the south. There are three escapement indicator stocks representing the production of NOC Chinook salmon: the Nehalem, Siletz, and Siuslaw stocks. The geographic range of production encompassed by the NOC includes four additional major basins: the Tillamook, Nestucca, Yaquina and Alsea. The Tillamook drainage system includes five sub-basins: the Kilchis, Miami, Trask, Wilson and Tillamook rivers.

Forecasts for this aggregate are based on sibling regression relationships developed for each discrete population, both indicator and non-indicator stocks. The aggregated forecast for the NOC is the sum of the forecasts for the individual basins within the geographic range. These methods were developed in 2008 and are continually refined with each year's additional information. Prior to 2008, the aggregate forecast (and each of the indicator stock's forecasts) was based on a running three-year average.

##### 2.2.3.4.1.1 Nehalem River

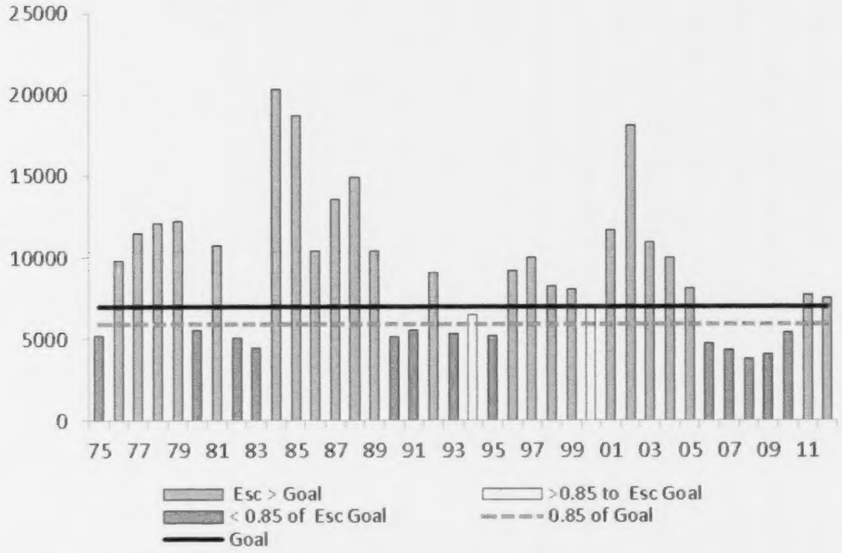

*Figure 2.2.3.4.1.1.–Nehalem River escapements of Chinook salmon, 1975–2012.*

**Escapement Methodology:** Both directed MR studies and historically conducted surveys were used to measure escapement during the past return year. Standard estimates are generated from conducting surveys of peak abundance in historically walked predefined areas of known Chinook salmon spawning habitat within the basin. These observations are then adjusted by estimates of the total available habitat, observer biases, the total run encountered during the peak count, and the bias seen between these predefined surveys and other survey areas that are randomly selected.

**Escapement Goal Basis:** The current point goal of 6,989 spawners was derived by Zhou & Williams in 1999 and was based on assessments of escapement made through normative survey methodology.

**Agency Comments:** This stock is being studied by the Sentinel Stock Committee's program to improve escapement estimation. Direct MR adult spawner estimation indicated an escapement of 12,952 Chinook salmon in 2012. Methods comparable to those used to generate the agreed to escapement goal for the Nehalem indicate 2012 escapement of 7,515 adult spawners. This is 108% of the current escapement goal. This is the second return year since 2005 that Nehalem Chinook salmon have met their escapement goal. While a terminal sport fishery was conducted from 2010 through 2012 return years, significant area closures, daily and seasonal bag restrictions were deployed to assist in the rebuilding of this stock. Based on sibling regression forecasting methods, the Nehalem is forecasted to meet the escapement goal in 2013. ODFW is engaged in analysis to best use results from recent MR experiments to reconstruct historic estimates from peak-counts observed in standard surveys.

#### 2.2.3.4.1.2 Siletz River Fall

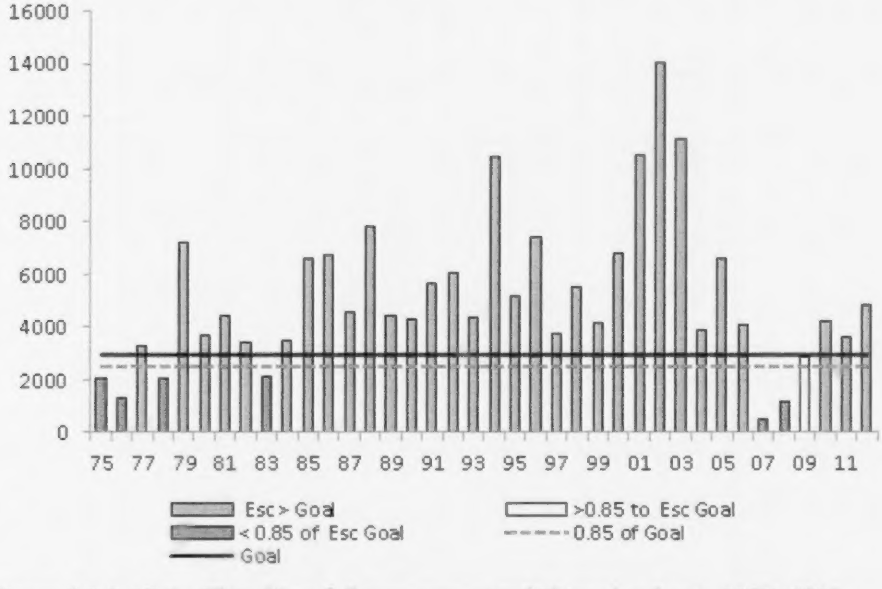

*Figure 2.2.3.4.1.2.–Siletz River fall escapements of Chinook salmon, 1975–2012.*

**Escapement Methodology:** Both directed MR studies and historically conducted surveys were used to measure escapement during the past return year. Standard estimates are generated from conducting surveys of peak abundance in historically walked predefined areas of known Chinook salmon spawning habitat within the basin. These observations are then adjusted by estimates of the total available habitat, observer biases, the total run encountered during the peak, and the bias seen between these predefined surveys and other survey areas that are randomly selected.

**Escapement Goal Basis:** The current point goal of 2,944 spawners was derived by Zhou & Williams in 2000 and was based on assessments of escapement made through standard survey methodology.

**Agency Comments:** This stock is being studied under the auspices of the Sentinel Stock Committee's program to improve escapement estimation. Calibration studies were initiated in the 2009 spawning year, and traditional methods of escapement estimation remain in place until MR experiment-based estimation is complete. The MR study of escapement in the Siletz resulted in an independent estimate of 8,738 adult spawners in 2012. Data used to derive the escapement goal are not directly comparable to MR based estimates of escapement. The estimate based upon historically produced habitat expansion methods for 2012 was 4,871 adult fall Chinook salmon. Significant terminal area sport fisheries restrictions which included substantial area closures, restrictive daily and seasonal bag limits are believed to have assisted in the achievement of the escapement goal. This stock is forecasted to exceed its escapement goal in 2013.

#### 2.2.3.4.1.3 Siuslaw River Fall

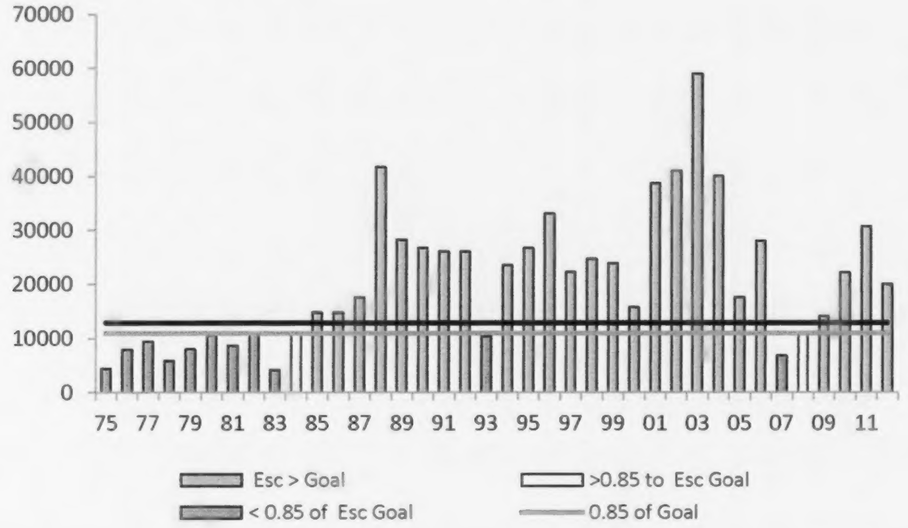

*Figure 2.2.3.4.1.3.– Siuslaw River fall escapements of Chinook salmon, 1975–2012.*

**Escapement Methodology:** Both MR-based calibration factors and historically conducted surveys have been utilized to measure escapement during 2012. Standard estimates are generated from conducting surveys of peak abundance in historically walked predefined areas of known Chinook salmon spawning habitat within the basin. These observations are then adjusted by estimates of the total available habitat, observer biases, the total run encountered during the peak, and the bias seen between these predefined surveys and those that are randomly selected. A simple ratio comparison between MR-based estimates and observations of peak abundance in standard survey areas was used to generate a calibrated estimate.

**Escapement Goal Basis:** The current point goal of 12,925 spawners was derived in 2000 by Zhou and Williams (2000) and was based on assessments of escapement made through standard survey methodology.

**Agency Comments:** The preliminary estimated spawner abundance in 2012 was 16,023 adult Chinook salmon based on methods employing five years (2002–2006) of peak counts on six standard surveys calibrated to MR-based escapement estimates. The current escapement goal estimate was based upon available habitat expansion escapement estimates, as used in other basins on the Oregon coast, but these estimates and goals will be obviated through the improvement of estimation techniques based upon the MR-based estimates. Escapement in 2012, estimated based on habitat expansion methods used to derive the escapement goal, was 20,018 adult spawners. Spawner–recruit analysis utilizing the MR-based data set will yield a new escapement goal (backcast through historical data sets). This stock is forecast to exceed the current escapement goal in 2013.

#### 2.2.3.4.2 Mid-Oregon Coast

The MOC aggregate has been proposed as an additional stock aggregate to be included in PSC management, pending analysis and review of escapement goals for the South Umpqua and Coquille. The MOC is bounded by the Umpqua on the north and the Elk Basin on the south, and includes two additional major basins, the Coos and Coquille, and two small basins, Floras Creek and the Sixes River.

There is a mixture of natural and hatchery production originating from the MOC, both of which are fall-returning, ocean-type life histories. The largest age classes which normally contribute to spawning escapement are 4- and 5-year-old adult fish; however, there are smaller proportions of spawning escapement that are observed each return year that are both 3- and 6-year-old fish. These Chinook are caught primarily in SEAK, NBC, PFMC and terminal fisheries.

Forecasts for MOC streams, except Elk River, are based on sibling regression relationships developed for each discrete population in 2008 and updated with each year's additional information. Elk River forecasts are based on projected survival rates of hatchery releases and recent proportions of wild adults in the aggregate return.

### 2.2.3.4.2.1 South Umpqua River Fall

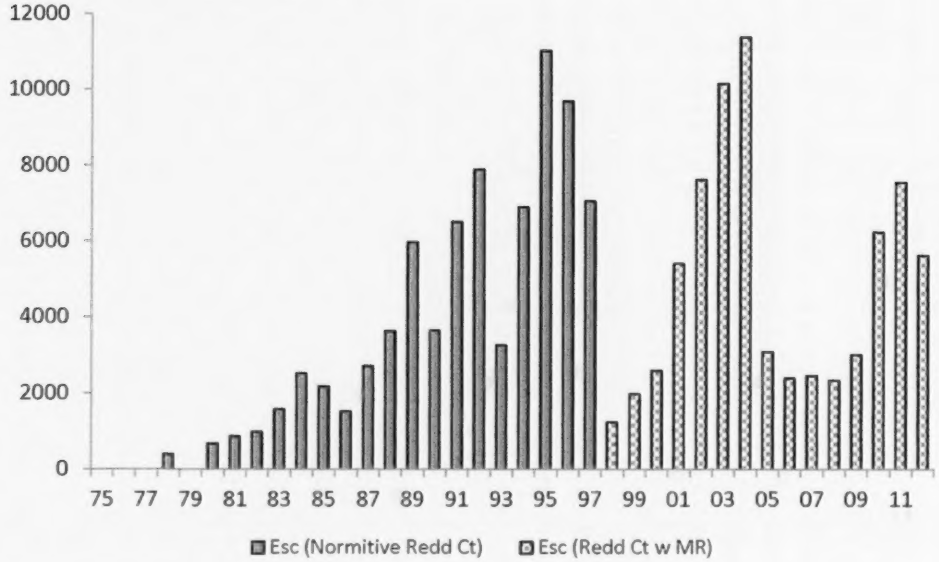

*Figure 2.2.3.4.2.1.–South Umpqua River escapement of fall Chinook salmon, 1978–2012.*

**Escapement Methodology:** Indices of Chinook salmon spawner abundance in the South Umpqua/Cow Creek sub-basin were derived from aerial redd count surveys calibrated to six years of MR study. The aerial surveys are funded by Douglas County and were conducted twice during the spawning season. Aerial redd counts were conducted on the lower 69 miles of the South Umpqua and the lower 60 miles of Cow Creek. These counts cover all mainstem spawning areas for fall Chinook salmon in the South Umpqua Basin. The South Umpqua is broken up into three reaches (Forks to Happy Valley, Happy Valley to Cow Creek, Cow Creek to Milo) and Cow Creek is considered as one reach from the confluence with the Umpqua River to Galesville Dam.

Aerial surveys are conducted using a Bell Ranger 3 helicopter; at least two flights are typically scheduled to encompass the peak spawning period. Two biologists simultaneously count redds for each reach using hand tally counters. At the end of the reach, each biologist records the number of redds identified and counters are reset for the next reach. The average of the two observers' Chinook salmon redd counts from each reach is used. The index is defined as the sum of the observed average of the peak counts for each reach between the two flights. Expansions are sometimes made to account for portions of reaches that were not completed due to visibility or mechanical problems.

**Escapement Goal Basis:** ODFW is currently engaged in analysis which will produce an escapement goal for this stock.

**Agency Comments:** Recoveries of coded wire tagged fall run Chinook salmon from the Umpqua River indicate that they are caught in PSC fisheries. Four years of U.S. CTC-funded research has allowed the calibration of redd counts to derive a fish-per-redd expansion factor to estimate annual escapements. The average expansion factor from these studies is 3.64 fish per redd. The CV of the expansion factor was found to be 29%, which indicates that the average expansion factor is a reasonably reliable statistic to use for annual estimates of escapement. The escapement estimate for 2012 was 5,635 adults based on redd count expansions.

#### 2.2.3.4.2.2 Coquille River Fall

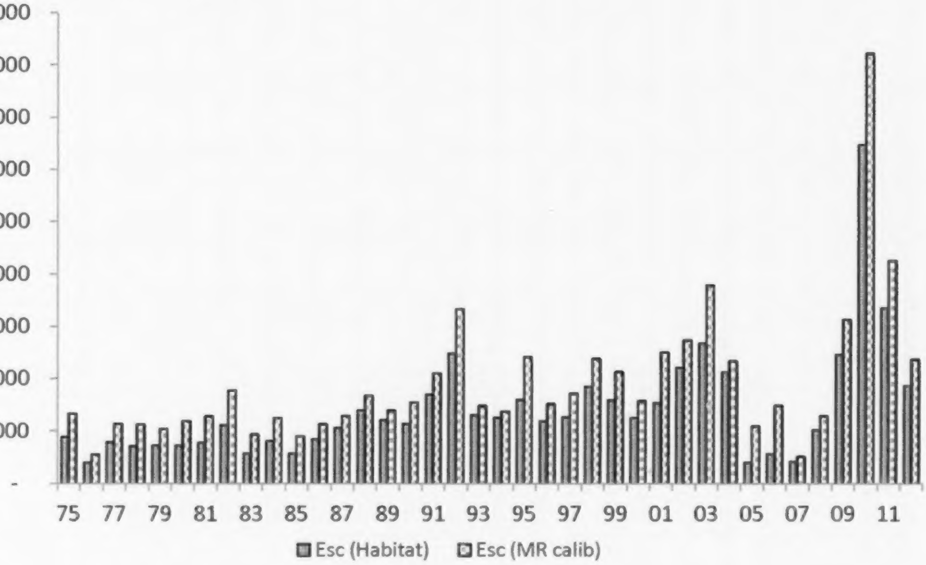

*Figure 2.2.3.4.2.2.–Coquille River escapement of fall Chinook salmon, 1975–2012.*

**Escapement Methodology:** Both MR study based calibration factors (Figure 2.2.3.4.2.2) and historically conducted surveys were used to measure escapement during the past return year. Standard survey methods are identical to those described in the Siuslaw, Siletz and Nehalem basins. A simple ratio comparison between those years of MR-based estimates and observations of peak abundance in standard survey areas have been used to generate a preliminary "calibrated" estimate. Values presented in the above graph are based on standard habitat survey estimations along with the calibrated values. Both standard and MR calibrated estimates may be found in the appendix tables.

**Escapement Goal Basis:** ODFW is currently engaged in analysis which will produce an escapement goal for this stock.

**Agency Comments:** Methods based on MR-calibrated analysis yield a preliminary adult Chinook salmon escapement estimate for the Coquille Basin of 11,828 spawners in 2012. The traditional habitat expansion-based estimate is only somewhat lower at 9,300 adult fish. Analysis funded by the CTC is underway that will provide information to designate Coquille Fall Chinook salmon as an escapement indicator stock for the MOC. An index of peak counts from standard surveys calibrated to MR abundance estimates has been selected as an efficient and cost-effective means to measure spawner escapement of Chinook salmon for use in PST fisheries management.

The U.S. CTC recommends that a CV of less than 30% should be achieved in order for an index to be used as an estimator of abundance within the Chinook salmon management scheme. The average CV among the qualifying calibration values computed from studies conducted from 2001 through 2004 for the Coquille River basin is was 14%.

Improvements in applying those calibrated values towards the estimation of this and other Oregon Coastal stocks are currently being reviewed and discussed within the agency. It is anticipated that historical time series for each of the basins which have MR calibration studies (Nehalem, Siletz, Siuslaw, S. Umpqua and Coquille rivers) will be updated in a subsequent reporting cycle.

# 3 STOCK STATUS

## 3.1 Paragraph 13 (c) Analysis

Paragraph 13 of the 2009 Agreement describes a process to implement additional management actions in AABM and ISBM fisheries if the management as prescribed in paragraphs 8 and 10 fail to meet MSY or other biologically based escapement objectives. Paragraph 13 of the PST details a process for evaluating stock groups and indicator stocks listed in Attachments I–II to determine if additional management actions should be implemented in AABM fisheries. If additional management action is required, the ISBM fisheries listed in Attachments IV and V for those stock groups would commensurably be reduced to increase the escapements of the depressed stocks within the stock groups triggering the additional management actions. The CTC is to notify the commission of any required fishery restrictions to be implemented under Paragraph 13 at the February annual meeting.

Additional management actions for SEAK or NBC AABM fisheries would reduce Table 1 catch limits by 10% if a majority of stocks with agreed management objectives in at least two of the stock groups listed in Attachment I and II of the Chinook Annex were observed:

- at least 15% below their escapement goal management objectives for the past year and are forecast to be at least 15% below their escapement goal objectives in the upcoming year; or
- at least 15% below their escapement goal objectives for the past two consecutive years (unless a forecast for escapement will exceed the escapement objective in the coming year).

If three or more stock groups in Attachments I and II meet the criteria to trigger additional management action, Table 1 catch limits in the relevant AABM fishery would be reduced by 20%. For the WCVI AABM fishery, Attachment III of the 2009 Agreement lists stock groups applicable to the obligations defined in paragraph 13. However, in consideration of the 30% reduction in catch limits for the WCVI AABM fishery, the 2009 Agreement states that additional actions will not be taken for this fishery except as otherwise may be agreed by the Commission.

The 2009 Agreement directs the CTC to provide a review of Attachments I–V by 2014 or earlier, to determine if the current lists of stock groups continue to be appropriate, if there are new criteria that could be employed to revise stock group listings for each attachment, and whether any changes to the Attachments proposed by a Party may be appropriate. In the interim, the CTC in this report provides an evaluation of the stocks listed in Attachments I–III following the criteria described in Paragraph 13 (c).

In Table 3.1, the CTC summarizes the performance of the stock groups and the criteria for additional management action, based upon observed escapements and exploitation rates through 2012 and stock forecasts for 2013.

For SEAK and NBC AABM fisheries, the stock groups in Attachments I and II are identical; thus they are combined in Table 3.1. All stocks relevant to Paragraph 13 decisions for SEAK and NBC AABM fisheries have escapement-based management objectives. Although not meeting management objectives does not automatically trigger reductions in the WCVI AABM fishery, the CTC included an evaluation of the stock groups in Attachment III to inform the Commission about their performance. For the WCVI AABM fishery, the Puget Sound summer/fall stock group includes three stocks with exploitation rate management objectives that have yet to be submitted for CTC review.

*Table 3.1.–Evaluation of criteria for initiating additional management action in regards to Paragraph 13 of Chapter 3 of the 2009 PST Agreement.*

| Fishery | Stock Group | Stocks | Stocks with agreed objective | Number below threshold (2011 and 2012) | Stocks with a 2013 forecast | Number of 2013 forecasts below threshold | Paragraph 13 criteria met |
|---|---|---|---|---|---|---|---|
| SEAK/ NBC | North/Central British Columbia | 3 | 0 | NA | 0 | NA | No |
| | Upper Strait of Georgia | 5 | 0 | NA | 0 | NA | No |
| | West Coast Vancouver Island Falls | 7 | 0 | NA | 0 | NA | No |
| | Far North Migrating Oregon Coastal Falls | 3 | 3 | 0 | 3 | 0 | No |
| | Columbia River Falls | 3 | 3 | 0 | 2 | 0 | No |
| | Columbia River Summers | 1 | 1 | 0 | 1 | 0 | No |
| | Washington Coastal Fall Naturals | 5 | 3 | 0 | 3 | 0 | No |
| | Fraser Early (Spring & Summers) | 3 | 0 | NA | 0 | NA | No |
| WCVI | Columbia River Falls | 3 | 3 | 0 | 2 | 0 | No |
| | Fraser Late | 1 | 1 | 0 | 1 | 1 | Yes |
| | Puget Sound Natural Summer/Falls | 5 | 0 | NA | 0 | NA | No |
| | Columbia River Summers | 1 | 1 | 0 | 1 | 0 | No |

*Note: When the stock group cannot be evaluated because an insufficient number of stocks in the group have agreed escapement objectives, or that forecasts were not provided to the CTC for stocks with agreed escapement objectives, NA is shown.*

No stock groups listed in Attachment I–III met the criteria for triggering additional management action under Paragraph 13 (c) for the 2011 and 2012 observed escapements. The 2012 observed escapements and 2013 forecasts (Table 3.1) indicate that one stock group (Fraser late, i.e., Harrison River) potentially meets criteria for the flagging of Paragraph 13. However, Paragraph 13 (g) specifies that no further reduction will be taken in the WCVI fishery unless otherwise agreed by the PSC. Further, the CTC has expressed that it is not practical to use forecasts for Paragraph 13.

Note that ISBM obligations for 2012 cannot be calculated for most Oregon and Washington stocks until 2014 because of the delay in availability of required CWT data under most southern U.S. monitoring programs.

Only 5 of the 10 different stock groups in Table 3.1 have stocks with agreed management objectives that can be evaluated for triggering additional management action (Far North Migrating Oregon Coastal falls, Columbia River falls, Columbia River summers, Washington Coastal fall naturals, and Fraser lates). These 5 stock groups contain 13 stocks, of which 11 have agreed escapement objectives. Of the 11 stocks with agreed escapement objectives, forecasts for 2013 were available for 11 (Table 3.1). The CTC has identified a need to develop management objectives and forecast capabilities for more of the stocks and stock groups included in Attachments I–III to improve the efficacy of the Paragraph 13.

As stated previously, the CTC is to notify the Commission of any required fishery restrictions to be implemented under Paragraph 13 (c) at the February annual meeting; however, due to the delay in compiling escapement data for 2012 and forecasts for 2013, the Paragraph 13 escapement analysis was not completed until well after the February due date. Much of the data were not available until late April. Also, in January 2013 the CTC advised the Chinook Interface Group that annual escapement forecasts are not practical for use in Paragraph 13 (c) for determining if additional management action is warranted. To meet the timing requirement for implementation of Paragraph 13 (c), the CTC would need the following before the February annual meeting: a) escapement and exploitation rate estimates for the prior year, and depending upon the recommendations of the Chinook Interface Group and the Commission, b) projections of exploitation rates and forecasts of escapements for the coming year for stocks included in Paragraph 13, Attachments I–V. The CTC has developed a computer program with the capability to evaluate stock status and exploitation rate provisions under Paragraph 13 (d) and (e) but the availability of this analysis in February for the current management year remains an issue.

Since the January meeting with the Chinook Interface Group, the CTC has carried out the evaluation of the Paragraph 13 (c) criteria to provide insight into the current status of stocks in relation to the criteria and to identify data needs for the application of Paragraph 13. The evaluation for Paragraph (d) and (e) will be provided in the 2013 Exploitation Rate Analysis and Model Calibration report.

## 3.2 Synoptic Evaluation of Stock Status

The following sections include graphics to display stock status information consisting of escapement and exploitation figures with spawning escapement on one axis and exploitation rate on the other. These synoptic plots display summary information for individual escapement indicator stocks. The figures present both the current status of stocks and the history of the stocks relative to PST management objectives using escapement data, CTC accepted MSY management objectives (or, in some cases, habitat model or agency stock-recruitment based escapement objectives that have yet to be submitted to the CTC or agreed upon by the CTC), and exploitation rates from CWT indicator stocks to clearly summarize the performance of the stocks and fisheries management relative to established or potential goals.

The plots resemble those presented for groundfish in Garcia and De Leiva Moreno (2005). A general depiction of the plots with three reference lines is in Figure 3.2.1. The plots show the annual observations of a stock with regard to fishing rate (x-axis) and escapement abundance (y-axis) from one year to the next. There are three reference lines, one for fishing mortality ($U_{SMSY}$) and two for escapement abundance ($S_{MSY}$, $0.85*S_{MSY}$) that define five areas. The definition of reference points for PST Chinook salmon stocks is based on the management objectives (escapement and exploitation rate) identified in the 2009 Agreement. The lower reference line for escapement on the synoptic plots is set at $0.85*S_{MSY}$ due to language in Paragraph 13 of the 2009 Agreement. For stocks with escapement objectives defined as ranges (SEAK, TBR, and the Harrison River), the lower reference line has been defined as 85% of the lower bound of the escapement range and the upper reference line has been set as the lower bound of the escapement range. The exploitation rate reference line ($U_{SMSY}$) is the exploitation rate at $S_{MSY}$ for stocks with escapement objectives.

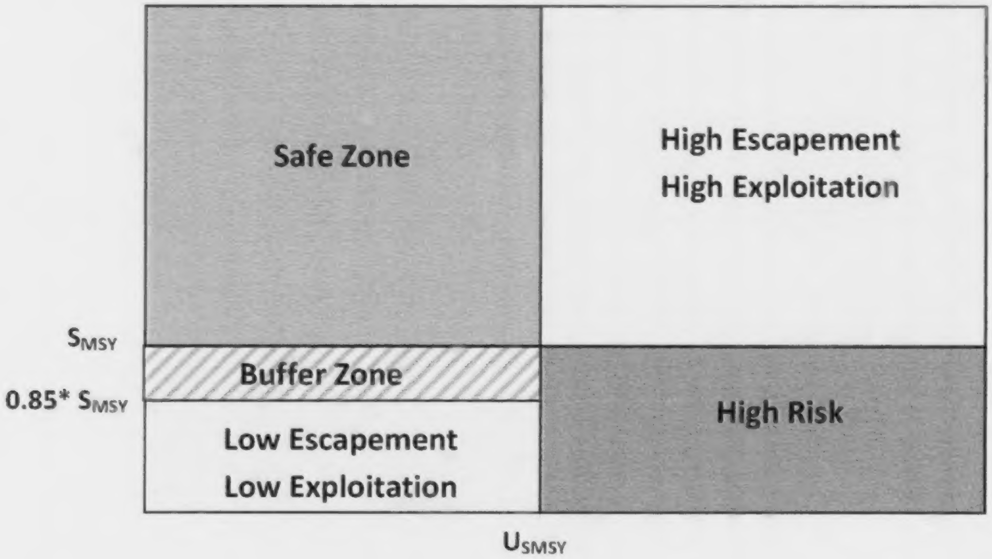

*Figure 3.2.1. –Precautionary plot for synoptic evaluations of PST Chinook salmon stocks.*

The three reference lines produce five zones in the synoptic plots. The green area (Safe Zone) in Figure 3.2.1 represents a healthy stock status where fishing is below $U_{MSY}$ and the concurrent stock spawning abundance is above the specified escapement goal. The area of high risk (High Risk) is shaded red where a higher-than-prescribed fishing mortality is concurrent with low escapement abundance. The two yellow zones (High Escapement High Exploitation, Low Escapement Low Exploitation) represent situations in which the stock could be in danger of falling into an area of conservation concern; in the upper right (High Escapement High

Exploitation), escapement is at a healthy level, but fishing mortality is above the $U_{MSY}$ limit, and in the lower left (Low Escapement Low Exploitation), fishing is occurring below the $U_{MSY}$ limit and the population is below a desired minimum escapement. The cross-hatched region is the PSC buffer zone, indicating problems may arise in the future.

Exploitation rates used in the synoptic plots are one of the following: CY exploitation rates, pre-terminal cumulative mature-run equivalent exploitation rates, or total (pre-terminal and terminal) cumulative mature-run equivalent exploitation rates. Total cumulative mature-run equivalent exploitation rates cannot be used when there is a terminal fishery that is directed on the hatchery indicator stock because the terminal exploitation will differ from that on the wild stock being represented. The ages used in the escapement and exploitation rate calculations are not the same for each stock presented in the synoptic charts below, and typically exclude age 2 for ocean-type stocks and age 3 for stream-type stocks. See Table 3.2.1 for more detail.

Calendar year exploitation rates are computed as:

$$CYER_{CY} = \frac{OceanMorts_{CY} + TermMorts_{CY}}{(OceanMorts_{CY} + TermMorts_{CY} + OESC_{CY})}$$

Cumulative MRE exploitation rates are computed as:

$$CMREER_{CY} = 1 - \left(\frac{OESC_{CY}}{PESC_{CY}}\right)$$

Where

$$OESC_{CY} = \sum_{a=startage}^{maxage} OESC_{CY,a}$$

$$PESC_{CY} = \sum_{a=startage}^{maxage} PESC_{CY,a}$$

$$PESC_{CY,a} = \frac{OESC_{CY,a}}{CumSurvRte_{CY-a,a}}$$

When computing total (pre-terminal and terminal) MRE exploitation rates, the cumulative survival rate is computed for each age in a brood year as:

$$CumSurvRte_{BY,a} = TermSurvRte_{BY,a} * \prod_{i=startage}^{a} PreTermSurvRte_{BY,i}$$

When computing pre-terminal MRE exploitation rates the cumulative survival rate is computed for each age in a brood year as:

$$CumSurvRte_{BY,a} = \prod_{i=startage}^{a} PreTermSurvRte_{BY,i}$$

The pre-terminal harvest rates for each age in a brood year are computed as:

$$PreTermHR_{BY,a} = \frac{OceanMorts_{BY,a}}{CohortSizeANM_{BY,a}}$$

The pre-terminal survival rates for each age in a brood year are computed as:

$$PreTermSurvRte_{BY,a} = 1 - PreTermHR_{BY,a}$$

*Table 3.2.1.–Parameter definitions for all equations used to estimate CY exploitation rates and cumulative mature-run exploitation rates.*

| Parameter | Description |
|---|---|
| $a =$ | age |
| $BY =$ | Brood year |
| $CY =$ | Calendar year |
| $CMREER_{CY} =$ | Cumulative mature-run equivalent exploitation rate for calendar year *CY* |
| $CohortSizeANM_{BY,a} =$ | Cohort size after natural mortality for brood year *BY* and age *a* |
| $CumSurvRte_{BY,a} =$ | Cumulative survival rate for brood year *BY* and age *a* |
| $CYER_{CY} =$ | Calendar year exploitation rate for calendar year *CY* |
| $OceanMorts_{BY,a} =$ | Ocean mortalities for brood year *BY* and age *a* |
| $OESC_{CY} =$ | Observed escapement for calendar year *CY* |
| $OESC_{CY,a} =$ | Observed escapement for calendar year *CY* and age *a* |
| $PESC_{CY} =$ | Potential escapement for calendar year *CY* |
| $PESC_{CY,a} =$ | Potential escapement for calendar year *CY* and age *a* |
| $PreTermHR_{BY,a}=$ | Pre-terminal harvest rate for brood year *BY* and age *a* |
| $PreTermSurvRte_{BY,a} =$ | Pre-terminal survival rate for brood year *BY* and age *a* |
| $TermMorts_{CY} =$ | Terminal mortalities for calendar year *CY* |
| $TermSurvRte_{BY,a} =$ | Terminal survival rate for brood year *BY* and age *a* |

For many escapement indicator stocks, data necessary to plot the stock trajectories are available (Table 3.2.2). Most escapement indicator stocks have companion exploitation rate indicator stocks that are assumed capable of reflecting the exploitation rates in pre-terminal areas. With suitable assumptions about terminal area fisheries, the total exploitation rates on stocks can be estimated. Most areas along the coast have escapement indicator stocks. Notable exceptions are the UGS area, the west coast of Vancouver Island area and the Fraser River early stocks (spring and summer). For UGS, the CTC in the past has reported escapement for an aggregate. In future catch and escapement reports, the CTC will provide the individual metrics in addition to the aggregate numbers. The Fraser early stock consists of additional complexities for escapement indicator stocks, which are delineated on the basis of life history, and the stocks listed in Attachments I, II, and IV, which are based on geography. Region-specific synoptic evaluations of Chinook salmon stocks are presented in Section 3.3.

*Table 3.2.2.–Summary of information available for synoptic stock evaluations.*

| Region | Escapement Indicator | $S_{msy}$ | 85% of $S_{msy}$[1] | Exploitation Rate Indicator | $U_{msy}$ | Type of Exp. Rate[2] |
|---|---|---|---|---|---|---|
| SEAK | Situk | 600 | 425 | Situk wild | 0.81 | CY |
| SEAK | Chilkat | 2,200 | 1,488 | Chilkat wild | 0.40 | CY |
| SEAK | King Salmon | 150 | 102 | Alaska Hatchery (Crystal Lake) | 0.73 | CMRE |
| SEAK | Andrew Creek | 800 | 553 | Alaska Hatchery (Crystal Lake) | 0.67 | CMRE |
| SEAK | Unuk | 2,764 | 1,530 | Unuk wild | 0.60 | CMRE |
| SEAK | Chickamin (survey index) | 525 | 383 | Alaska Hatchery (Neets, Whitman, Deer) and Unuk wild | 0.72 | CMRE |
| SEAK | Blossom | 750 | 493 | Alaska Hatchery (Neets, Whitman, Deer) and Unuk wild | 0.64 | CMRE |
| SEAK | Keta | 750 | 446 | Alaska Hatchery (Neets, Whitman, Deer) and Unuk wild | 0.62 | CMRE |
| SEAK/TBR | Alsek | 4,677 | 2,975 | Alsek wild | 0.58 | CY |
| SEAK/TBR | Taku | 25,500 | 16,150 | Taku wild | 0.59 | CY |
| SEAK/TBR | Stikine | 17,400 | 11,900 | Stikine wild | 0.42 | CY |
| BC | Harrison | 75,072 | 63,811 | Chilliwack | 0.57 | CMRE |
| BC | Cowichan | 6,514 | 5,537 | Cowichan | 0.69 | CMRE |
| BC | Kitsumkalum | 8,621 | 7,328 | Kitsumkalum | 0.61 | CMRE |
| BC | Atnarko | 5,048 | 4,291 | Atnarko | 0.77 | CMRE |
| BC | Nicola | 8,159 | 6,935 | Nicola | 0.60 | CMRE |
| BC | L Shuswap | 12,799 | 10,879 | L Shuswap | 0.73 | CMRE |
| COLR | Columbia Upriver Summer | 12,143 | 10,322 | Columbia Summers | 0.75 | CMRE |
| COLR | Columbia Upriver brights | 40,000 | 34,000 | Upriver brights | 0.56 | CMRE |
| COLR | Deschutes River Fall | 4,532 | 3,852 | Lewis R Wild | 0.79 | CMRE |
| COLR | Lewis River Fall | 5,791 | 4,922 | Lewis R. Wild | 0.79 | CMRE |
| WAC | Quillayute Fall | 3,000 | 2,550 | NA |  | NA |
| WAC | Queets Spr/Sum | 700 | 595 | NA |  | NA |
| WAC | Queets Fall | 3,000 | 2,550 | Queets Fall Fing. | 0.74 | CMRE |
| WAC | Hoh Spr/Sum | 900 | 765 | NA |  | NA |
| WAC | Hoh Fall | 1,200 | 1,020 | NA |  | NA |
| ORC | Nehalem | 6,989 | 5,941 | Salmon River | 0.69 | NA |
| ORC | Siletz | 2,944 | 2,502 | Salmon River | 0.81 | NA |
| ORC | Siuslaw | 12,925 | 10,986 | Salmon River | 0.61 | NA |

[1] Stocks with an escapement goal range use 85% of the lower bound.

[2] Two types of exploitation rates were used: cumulative mature-run equivalents (CMRE) and calendar year (CY) which are based off of actual stock assessment data gathered annually for each stock.

A synoptic summary figure for 24 stocks for 2011 data shows that the majority were in the safe zone (Figure 3.2.2). No stocks were in the high risk zone; however, three stocks (Situk, Nicola, and Cowichan) were in the low escapement and low exploitation zone. Two stocks (Deschutes Falls and Columbia Upriver brights) experienced high exploitation, but their escapements exceeded escapement goal objectives. When stock status was examined by region there was not a strong regional pattern, other than for Washington Coast.

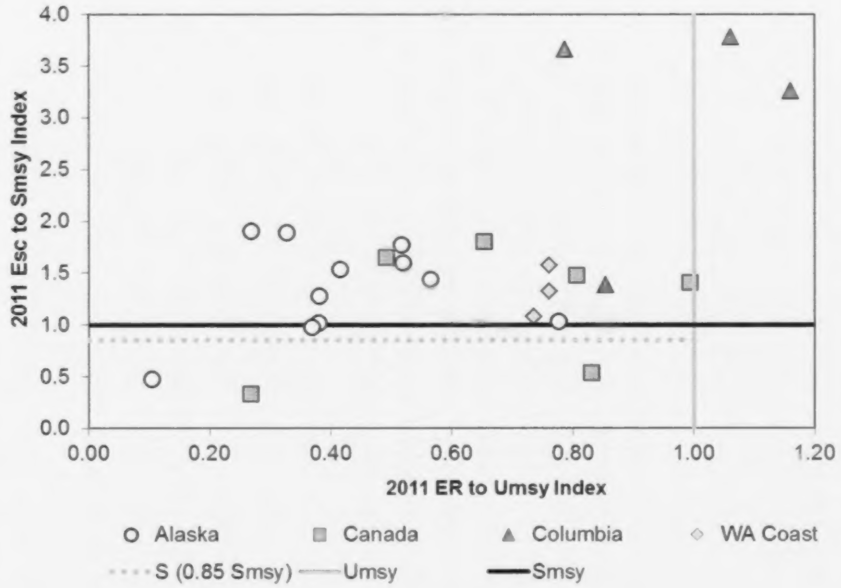

*Figure 3.2.2. –A synoptic summary by region of stock status for stocks with escapement and exploitation rate data in 2011.*

*Note: Escapement and exploitation rate data were standardized to the stock-specific escapement goal and $U_{MSY}$ reference points.*

## 3.3 Regional Trends and Profiles

### 3.3.1 Southeast Alaska and Transboundary River Stocks

Recent declines in Chinook salmon productivity and abundance are widespread and persistent throughout Alaska, particularly in western and northern Alaska. Analysis of productivity of Chinook salmon stocks throughout Alaska with stock-recruit relationships reveals that temporal patterns in residuals differed considerably prior to 2001. Beginning with brood year 2001, residuals for most of these stocks are consistently negative (Figure 3.3.1.1; ADF&G 2013). This pattern indicates that productivity was consistently lower than would be expected given the density-dependent effect of abundance of spawning adults since brood year 2001. These declines in productivity would have begun to negatively affect run abundances during 2005 when age-4 fish returned to spawn, but would have fully affected run abundances during 2007 through to the present when all age classes would have been affected by a decline in productivity. For more than half of the stocks included in Figure 3.3.1.1, recent measures of productivity are the lowest observed since data collection began in the 1970s. Available run abundance data for Chinook salmon in Alaska indicate significant declines were first fully detected in 2007 as expected from a persistent decline in productivity that began with returns from brood year 2001. Run abundance data available from 21 stocks in Alaska show substantial variability and moderate to no coherence among stocks prior to 2004 (Figure 3.3.1.2; ADF&G

2013). This was followed by consistent declines in run abundance across the state from 2007 to present. This is consistent with a downward trend in productivity and similar declines have been seen in the SEAK Chinook salmon stocks.

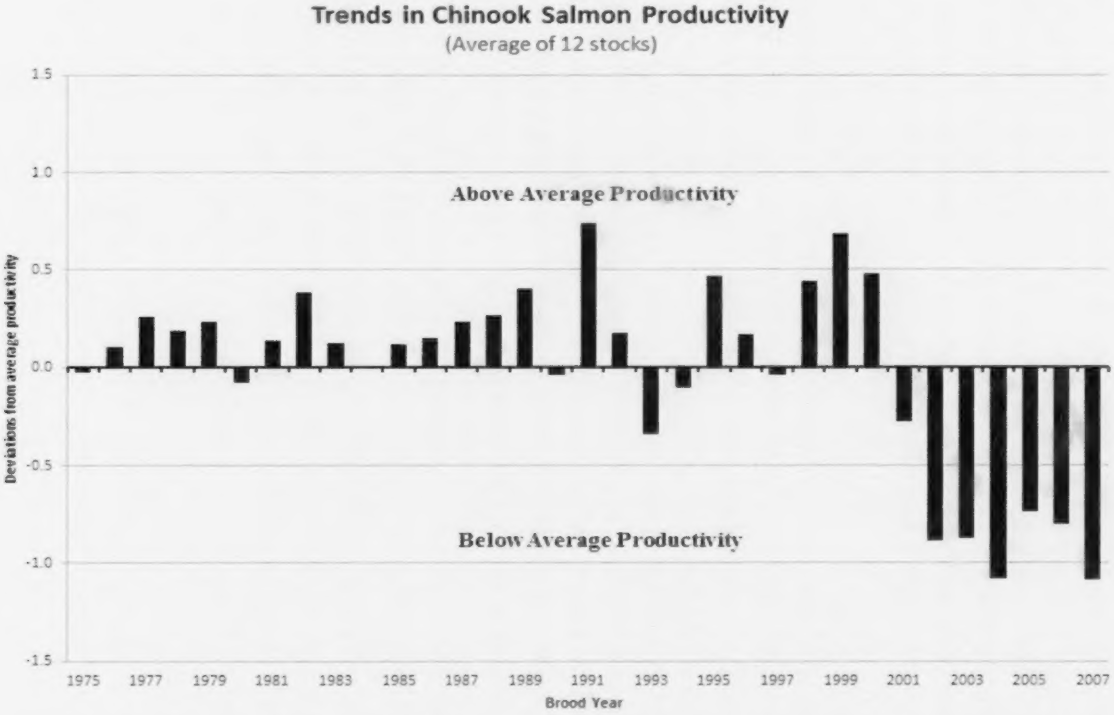

*Figure 3.3.1.1. –Average of standardized deviations from average productivity for 12 stocks of Chinook salmon in Alaska (the Kuskokwim, Canadian Yukon, and Nelson on the Alaska Peninsula; the Ayakulik and Karluk on Kodiak Island; the Anchor and Deshka in Cook Inlet; and the Situk, Alsek, Taku, Stikine, and Blossom in Southeast Alaska).*

The SEAK stocks have two main rearing behaviors that are consistent and predictable annually. One rearing behavior, outside rearing, is to rear in the Gulf of Alaska and Bering Sea after leaving the freshwater environment. The other behavior, inside rearing, is to rear in the nearshore environment of SEAK. Outside rearing stocks include the Situk, Alsek, Taku, and Stikine rivers stocks of Chinook salmon, and for the most part these fish strictly adhere to this behavior. Inside rearing stocks include the Chilkat, King Salmon, Unuk, Chickamin, Blossom and Keta rivers and Andrews Creek stocks and although the vast majority rear in the nearshore environment, CWT information suggests at least a small proportion of these fish exhibit outside rearing behavior. Productivity has decreased for both outside and inside rearing stocks; however, information suggests that some of the inside rearing stocks may have avoided the more prevalent declines in production associated with other SEAK and Alaskan stocks of Chinook salmon.

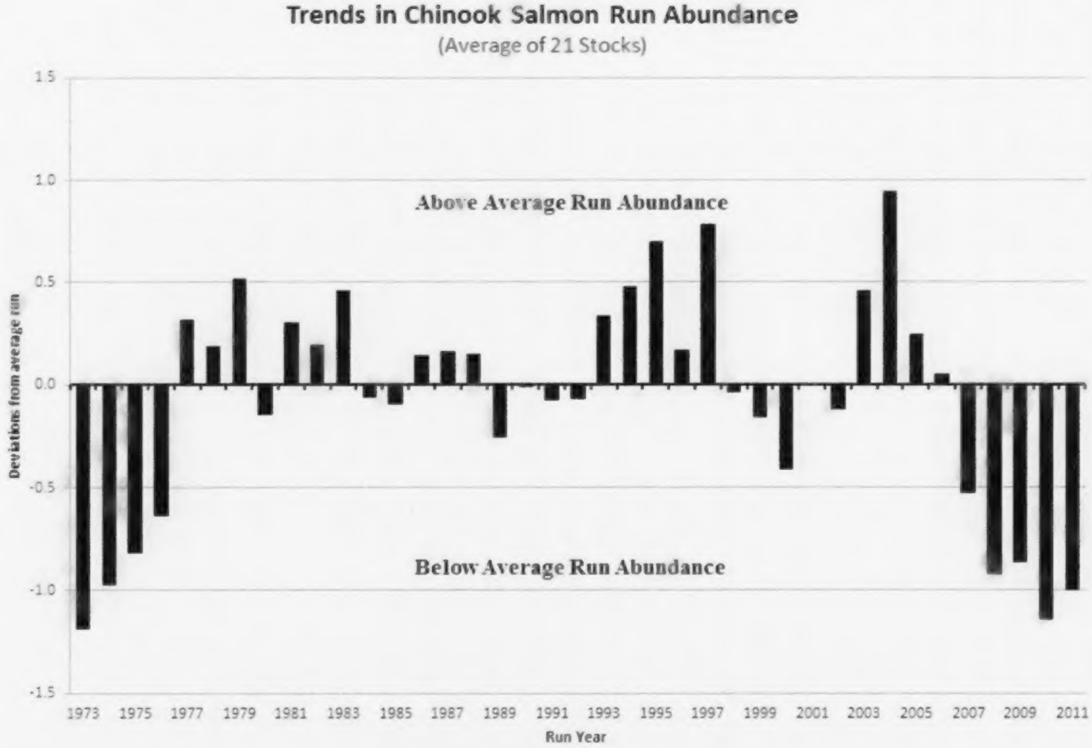

*Figure 3.3.1.2. –Average of standardized deviations from average run abundance for 21 stocks of Chinook salmon in Alaska (the Unalakleet, Nushagak, Goodnews and Kuskokwim in western Alaska; the Chena and Salcha on the Yukon River; the Canadian Yukon, the Chignik and Nelson on the Alaska Peninsula; the Karluk and Ayakulik on Kodiak Island; the Deshka, Anchor and late run Kenai in Cook Inlet, the Copper in the northeastern Gulf of Alaska, and the Situk, Alsek, Chilkat, Taku, Stikine, and Unuk in Southeastern Alaska).*

### 3.3.1.1 *Situk, Alsek, Taku, and Stikine Rivers Chinook Salmon Stock Status: Outside Rearing (Northern Gulf of Alaska and TBR)*

The Situk River stock has failed to meet the escapement goal in four of the last six years and the Alsek River stock has failed to achieve the goal in four of the last seven years. Over the past decade, these two stocks demonstrate the poorest performance in meeting escapement goals of all 11 SEAK TBR stocks, yet harvest rates exerted in recent years were very low, and among the lowest for all 11 SEAK/TBR stocks. Mature-run equivalent exploitation rates are not described for these two stocks since neither has a CWT program to estimate harvest. However, because harvests are mostly inriver or in the estuary, detailed catch accounting programs enumerate the vast majority of any SEAK harvest and CY exploitation rates are available. These fish are also outside rearing, thus, they are unavailable for harvest as rearing fish in SEAK. Exploitation rates for both stocks have been below, and have never exceeded, the threshold reference value (rates in 2011 and 2012 for the Situk River stock were about 10%; rates exerted on the Alsek River stock have never approached 50% of the $U_{msy}$ rate; Figure 3.3.1.1.1 and

Figure 3.3.1.1.2. The poor runs and escapement performance result from decreased productivity and mirror the very low productivity of other Alaskan stocks that rear in the Gulf of Alaska/Bering Sea. Management measures have been in place for both of these stocks to reduce harvests and increase escapement.

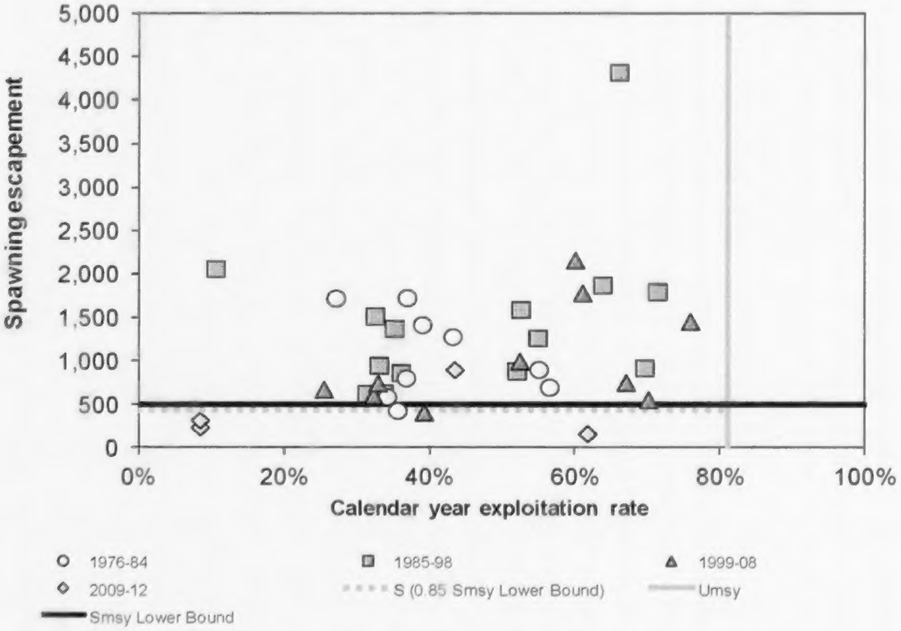

*Figure 3.3.1.1.1.–Calendar year exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement by CY for the Situk River stock of Chinook salmon, 1976–2012.*

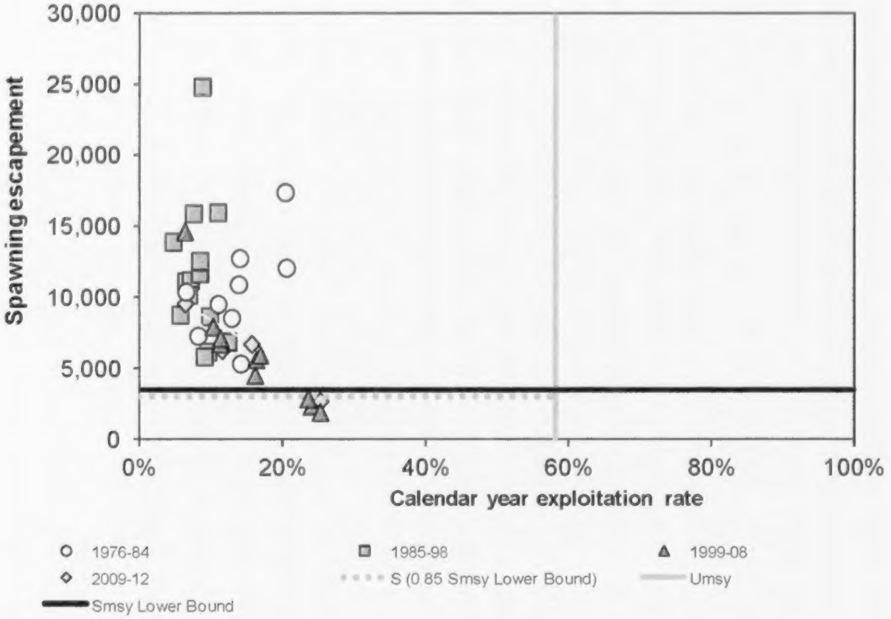

*Figure 3.3.1.1.2.–Calendar year exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement by CY for the Alsek River stock of Chinook salmon, 1976–2012.*

Even with very restrictive management measures, escapement goals for the Situk and Alsek river stocks may not be achieved in future years until survival improves leading to increased productivity and run abundances.

The Taku and Stikine river stocks have also demonstrated reduced productivity; however, the changes are more recent and the productivity decline is of a lesser magnitude than that of the Situk and Alsek river stocks and the other more northerly stocks in Alaska. Pre-season forecasts are developed for both the Taku and Stikine river stocks and directed fisheries are based on these forecasts and in-season run assessments and projections. Pre-season forecasts for the last few years have been higher than actual run abundance due to reduced productivity. In-season assessments have been used in both the U.S. and Canada to manage fishing. As a result, escapement goals have been achieved for both stocks in five of the six years since 2007 when poor productivity resulted in reduced runs.

For both the Taku and Stikine River stocks of Chinook salmon, new directed fisheries were implemented in years identified with surplus production beginning in 2005. As a result, in years of surplus production, exploitation rates have been higher and at times have exceeded the threshold reference value. These stocks are outside rearing and shortly after leaving each river as smolt, leave SEAK to rear in the Gulf of Alaska and Bering Sea and are not available for harvest in SEAK as rearing fish. Mature-run equivalent exploitation rates are not presented for these two stocks as the CWT marked fractions for both stocks are too low, typically less than 2%, producing inaccurate measures of harvest when using CWTs alone.

Prior to 2005, commercial fishing for these two stocks in the terminal area was closed or severely restricted since 1976. By default, harvests were germane to nearby sport, incidental catch in the traditional sockeye drift gillnet fisheries, a small number in the outside commercial troll, and any inriver fisheries. The onset of the new directed fisheries in 2005 emphasized the need to have more accurate measures of harvest and a genetic stock identification program was implemented. This program, when coupled with the methods described in McPherson et al. 2010 for CYs 1977 to 2007 for the Taku stock and in Bernard et al. 2000 for CYs 1981 to 1997 for the Stikine stock, has been used to provide CY estimates since 2005. CY exploitation rates since 1999 for the Taku stock have been low, averaging 22%, less than one-half of the threshold reference value (Figure 3.3.1.1.3). From 1975 to 2012, exploitation rates not approached or exceeded the threshold reference value. Annual exploitation rates for the Stikine River stock since 1999 have also been low, averaging 32% (Figure 3.3.1.1.4), below the threshold reference value of 42%.

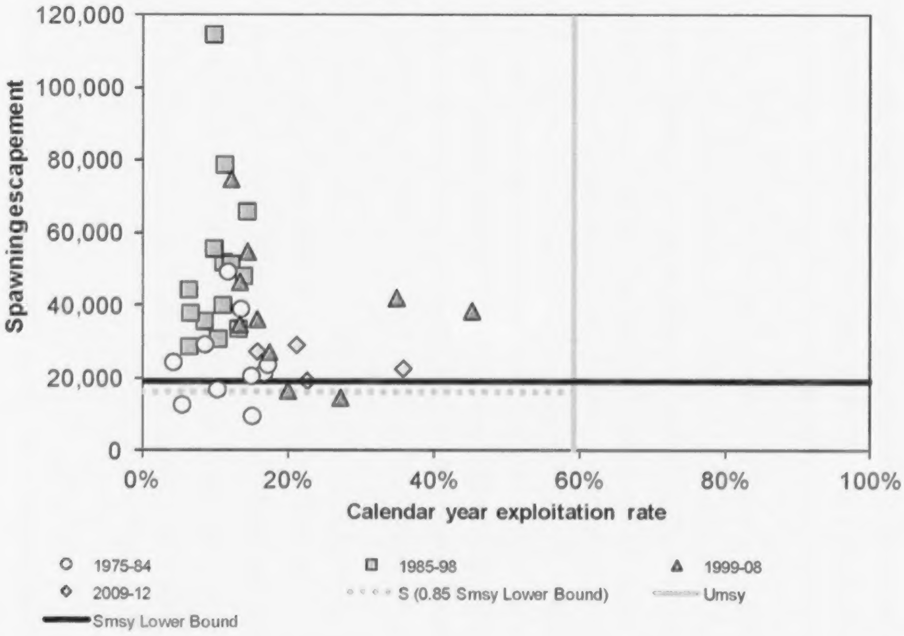

*Figure 3.3.1.1.3.–Calendar year exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement by CY for the Taku River stock of Chinook salmon, 1975–2012.*

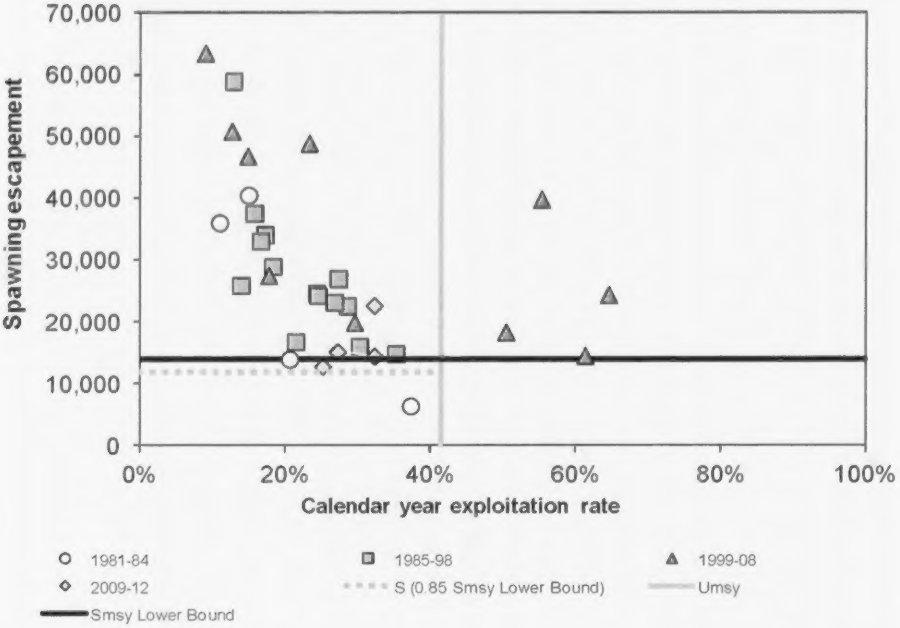

*Figure 3.3.1.1.4.–Calendar year exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement by CY for the Stikine River stock of Chinook salmon, 1981–2012.*

Until the low productivity regime associated with stocks that rear in the Gulf of Alaska/Bering Sea reverts to normative conditions, exploitation rates on Situk, Alsek, Taku, and Stikine rivers stocks (that are all outside rearing stocks), will need to remain well below the estimated sustainable rate. Even if exploitation rates remain low, escapement goals may not always be achieved.

Chinook salmon smolt abundance and survival has been estimated for the Taku River since the 1991 brood year. The data suggest that freshwater survival has been variable with no apparent trend from year to year; however, marine survival has undergone cycles throughout this period and for recent brood years it has been the lowest level since smolt abundance estimation began (Figure 3.3.1.1.5).

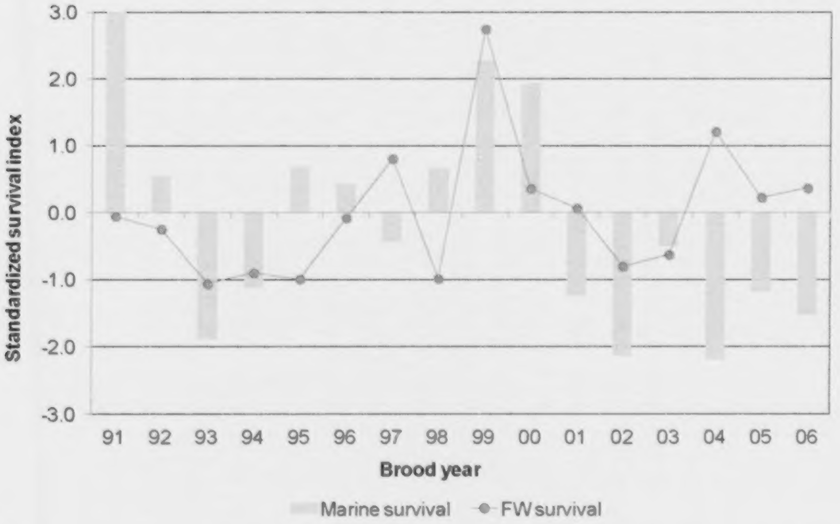

*Figure 3.3.1.1.5.–Freshwater and marine survival indices (standardized to a mean of zero) for the Taku River stock of Chinook salmon, 1991–2006 brood years.*

Smolt abundance and survival has been estimated for the Stikine River stock of Chinook salmon since the 1998 brood year. The data suggest that freshwater survival was favorable for brood years 1998 to 2001. Beginning with the 2002 brood year, it has been near average or well below average. At the same time, marine survival has been very low over the 2001 to 2006 brood years (Figure 3.3.1.1.6).

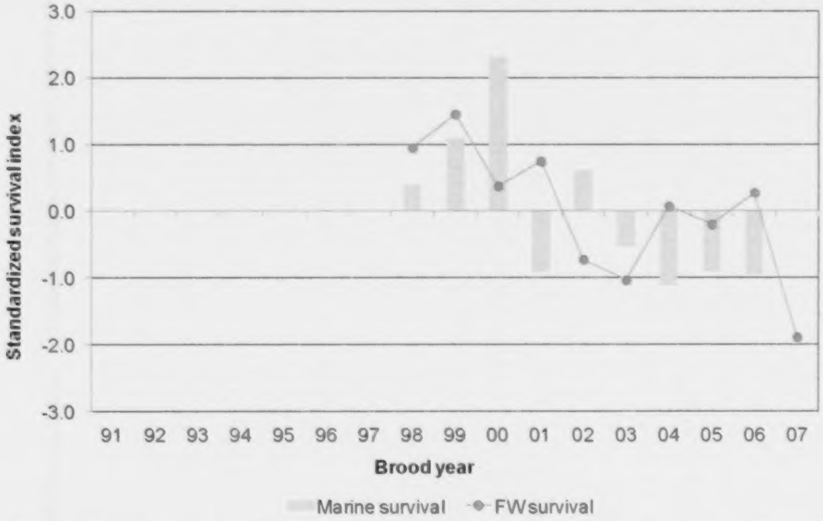

*Figure 3.3.1.1.6.–Freshwater and marine survival indices (standardized to a mean of zero) for the Stikine River stock of Chinook salmon, 1998–2007 brood years.*

### 3.3.1.2 *Chilkat and King Salmon Rivers and Andrew Creek Chinook Salmon Stock Status: Inside Rearing (Northern and Central SEAK)*

The Chilkat River, Andrew Creek, and King Salmon River stocks return to northern and central portions of SEAK and are inside rearing stocks. Both the Chilkat River and Andrew Creek stocks have failed to achieve escapement goals in two of the past six years and escapements for both have been decreasing over the last decade. The King Salmon River stock failed to achieve the escapement goal once in the last six years and escapements have been relatively stable over the last decade. The Chilkat River is located at the northern end of Lynn Canal and gillnet and sport fisheries in the upper canal can be managed to conserve the Chilkat River stock of Chinook salmon. Andrew Creek is the farthest downstream tributary of the Stikine River and management measures used to conserve Stikine River origin Chinook salmon during their spawning migration directly influence escapement patterns for the Andrew Creek stock. The King Salmon River is located on Admiralty Island and is the only documented island stock of Chinook salmon in SEAK. There are no directed fisheries that target the stock of King Salmon River Chinook salmon.

A successful CWT program is in place to estimate harvest for the Chilkat River stock of Chinook salmon. Mature-run equivalent exploitation rates from 2003 to 2011 on the Chilkat River stock of Chinook salmon have not exceeded the threshold reference value and have been on average about one-third of the threshold reference value (Figure 3.3.1.2.1). Undoubtedly some Chilkat River Chinook salmon are caught while rearing in SEAK but most harvest is presumed to be on mature fish and this is supported by CWT recovery information. In general, exploitation rates on the Chilkat River stock of Chinook salmon are some of the lowest seen by the CTC with a recent 10-year average exploitation rate of a mere 15%.

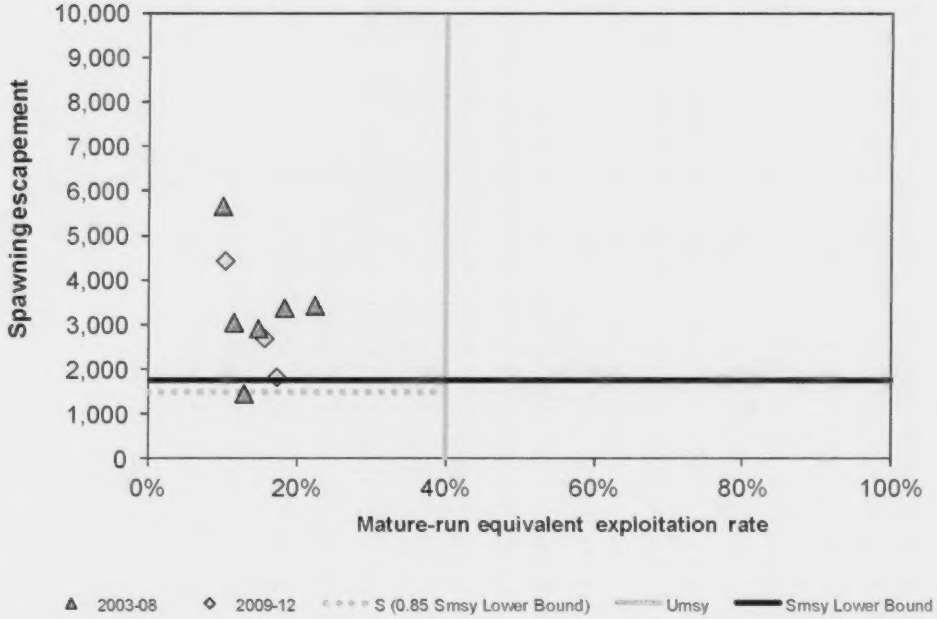

*Figure 3.3.1.2.1.–Mature-run equivalent exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement by CY for the Chilkat River stock of Chinook salmon, 2003–2011.*

Chinook salmon smolt abundance and survival have been estimated for the Chilkat River stock since the 1998 brood year. Freshwater survival has, for the most part, been below average with the exception of the 2006 brood year which, like the Unuk River stock, had the best freshwater survival on record. Marine survival was above average for brood years 1998 to 2001 and about average for the more recent broods (Figure 3.3.1.2.2).

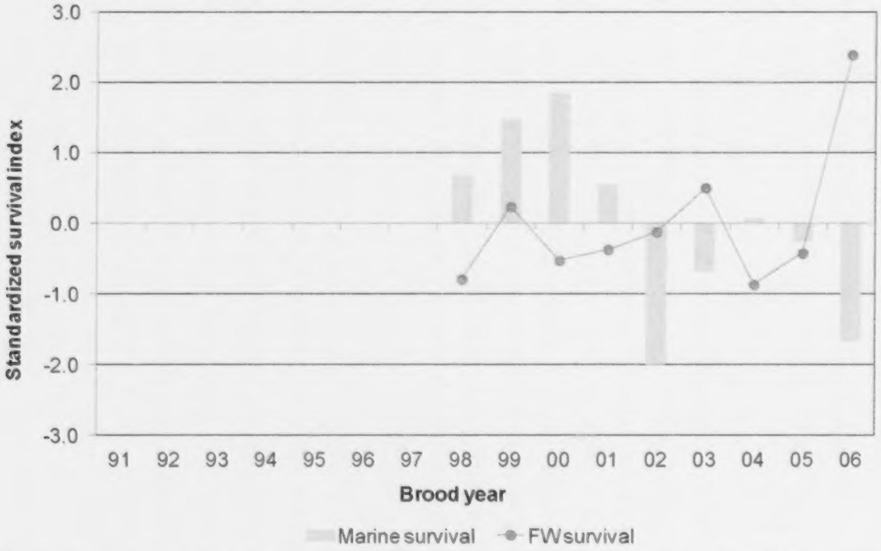

*Figure 3.3.1.2.2.–Freshwater and marine survival indices (standardized to a mean of zero) for the Chilkat River stock of Chinook salmon, 1998–2006 brood years.*

There is no CWT program in place to estimate harvest for the King Salmon River stock of Chinook salmon; therefore, mature-run equivalent exploitation rates from the nearby Crystal Lake hatchery, minus any terminal harvests, are used as surrogate values. Crystal Lake Hatchery uses Andrews Creek as a brood source, and like the King Salmon River stock, both stocks are inside rearing, centrally located, and are available to harvest as rearing and mature fish in SEAK. Since 1985, exploitation rates have not exceeded and only closely approached the threshold reference line in one year (1988) and have averaged a little over one-half the threshold reference line (Figure 3.3.1.2.3). Variations in survival that influence productivity are the primary influence on annual run abundance for this island stock of Chinook salmon. Harvest is incidental and management actions that can be taken to positively or negatively influence the exploitation rate on these fish are almost non-existent.

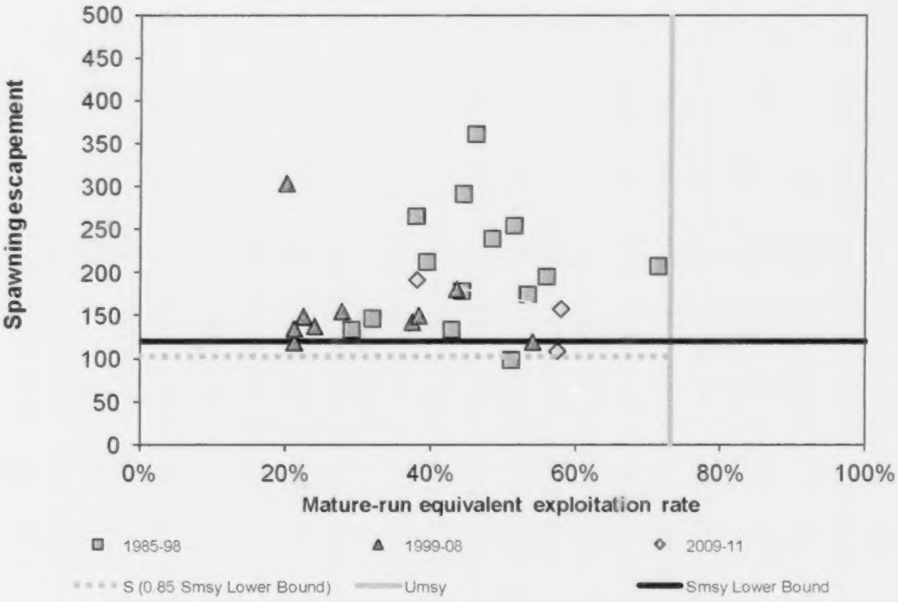

*Figure 3.3.1.2.3.–Mature-run equivalent exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement by CY for the King Salmon River stock of Chinook salmon, 1985–2011.*

There is no CWT program in place to estimate harvest for the Andrews Creek stock of Chinook salmon; therefore, mature-run equivalent exploitation rates from the nearby Crystal Lake hatchery, which uses Andrews Creek as a brood source, are used as surrogate values. Any terminal hatchery harvests were not included in the calculations.

Cumulative mature-run equivalent exploitation rates from the nearby Crystal Lake hatchery are used as surrogate values for the Andrew Creek stock. Since 1985, exploitation rates have only exceeded the threshold reference line in one year (1988) and have averaged about two-thirds of the threshold reference value (Figure 3.3.1.2.4). Variations in survival are a primary influence on annual run abundance. Some Andrew Creek Chinook salmon are caught while rearing in SEAK. Mature fish are subject to harvest as bycatch in terminal fisheries in District 8 when run abundance of Stikine-origin Chinook salmon is large enough to allow directed fisheries to occur. Lack of in-season information for the Andrew Creek stock and the fact that it is small relative to the Stikine River stock makes terminal in-season management of this stock difficult.

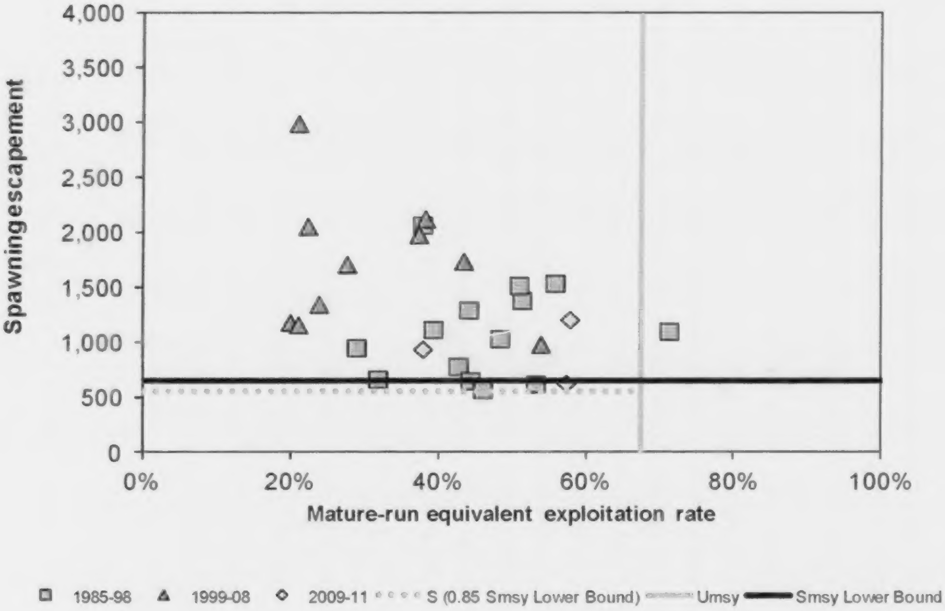

*Figure 3.3.1.2.4.–Mature-run equivalent exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement by CY for the Andrew Creek stock of Chinook salmon, 1985–2011.*

Below average productivity has negatively affected run abundance for the Chilkat River and Andrew Creek stocks in some years, but the effects are not as widespread or as negative as have occurred with offshore rearing stocks. The King Salmon River stock has demonstrated a more stable productivity regime, perhaps because of its spawning location in a very remote portion of an offshore island. Annual harvest rates have exceeded the threshold reference value only one time, for the Andrew Creek stock in 1988. Continued low harvest rates will be needed as productivity varies, particularly for the Chilkat River and Andrew Creek stocks of Chinook salmon to better ensure achievement of escapement goals.

### 3.3.1.3 *Unuk, Chickamin, Blossom, and Keta Rivers Chinook Salmon Stock Status: Inside Rearing (Southern SEAK)*

The Unuk, Chickamin, Blossom, and Keta rivers stocks of Chinook salmon all spawn in and around Behm Canal in southern SEAK and are all inside rearing stocks. Escapement trends for these stocks have been decreasing over the last six years. Since 2007, the Keta River stock has achieved its goal annually; however, the Unuk River and Chickamin River stocks each missed their escapement goals in 2012. The Blossom stock has only achieved its goal in three of the last six years and has fluctuated around the lower end of the goal range during this time. Fishing is closed for Chinook salmon in all of these rivers; furthermore, fishing is closed in most of Behm Canal. Southern SEAK stocks are harvested at relatively low rates while rearing and maturing and they are not harvested at all in terminal areas due to management closures. The bulk of the Southern SEAK stocks are harvested outside of the terminal areas and as returning mature fish.

Unique to this group of fish is their large size at age. The Unuk River stock of Chinook salmon are similar in size at age to other northern SEAK stocks; however, the Chickamin, Blossom, and Keta river stocks of Chinook salmon are substantially larger in size at age and include some of the largest Chinook salmon in the world. Moreover, the majority of ocean-age-2 Chinook salmon from the Chickamin, Blossom and Keta rivers are available to harvest in the sport and troll fisheries, exceeding on average the 28 inch legal length criteria for harvest. The increased contribution of these fish to the catch due to fast growth rates is another reason for the higher exploitation rates (2002–2011 average = 31%) than measured in the nearby Unuk River stock (2002–2011 average = 25%).

A very successful CWT program is in place to estimate harvest for the Unuk River stock of Chinook salmon. Some Unuk River Chinook salmon are caught while rearing in SEAK but most harvest occurs on mature fish and this is supported by CWT recovery information. Abundance of the 2012 Unuk River stock was low and preliminary information suggests the exploitation rate was the highest on record (Figure 3.3.1.3.1). Exploitation rates on this stock have averaged about one-half the threshold reference value. However, in 2012 the escapement goal was not met for the first time on record and if the exploitation rate was excessive in 2012 as suggested by preliminary information, this certainly contributed to the poor escapement and additional domestic management measures may be necessary if this pattern continues.

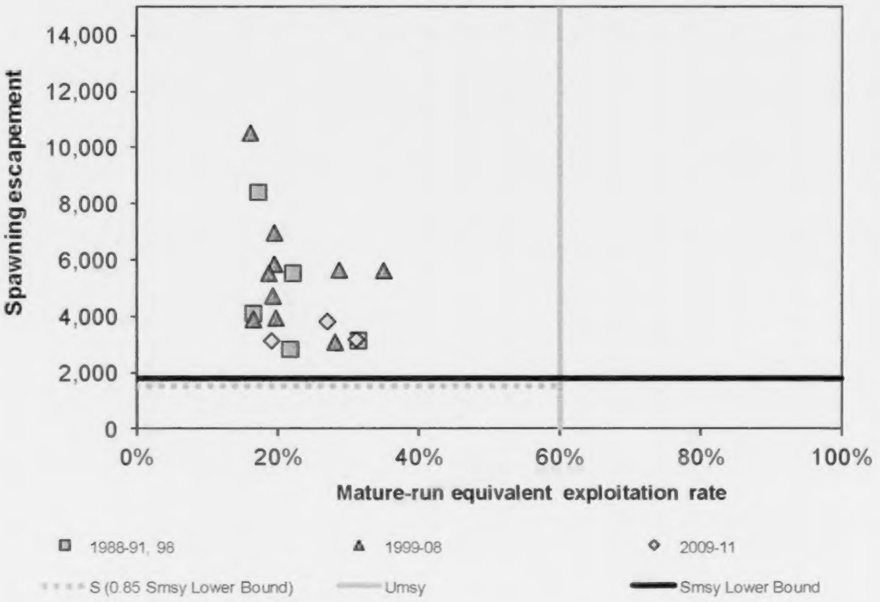

*Figure 3.3.1.3.1.–Mature-run equivalent exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement by CY for the Unuk River stock of Chinook salmon, 1988–1991 and 1998–2011.*

Chinook salmon smolt abundance and survival has been estimated for the Unuk River stock since the 1992 brood year. Freshwater survival has, for the most part, shown no apparent pattern. The 2003 and 2005 brood years were some of the lowest freshwater survivals on record; however, like the Chilkat stock, the 2006 brood year showed the best freshwater survival seen since the project began. Marine survival was near average and cycled annually over the 1991 to 2005 brood years. However, the 2006 and 2007 brood years declined and were the lowest marine survivals over the range of data (Figure 3.3.1.3.2).

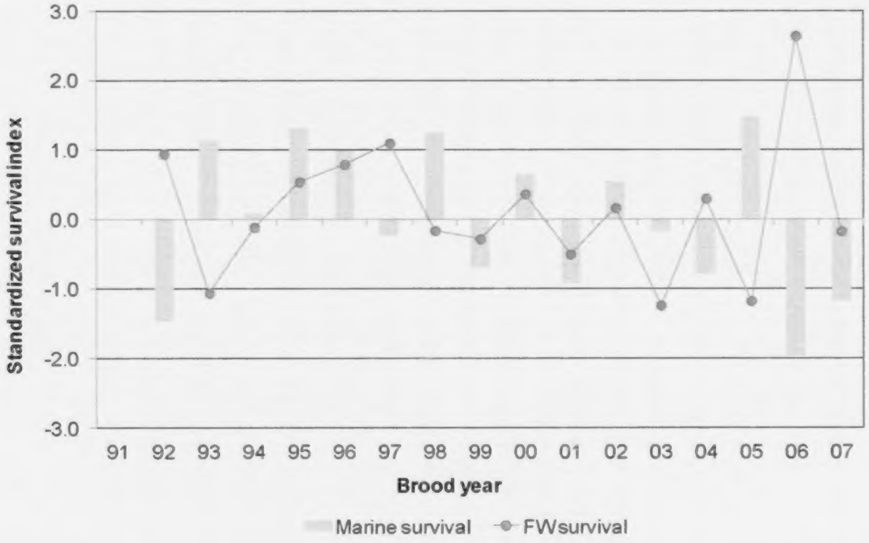

*Figure 3.3.1.3.2.–Freshwater and marine survival indices (standardized to a mean of zero) for the Unuk River stock of Chinook salmon, 1992–2007 brood years.*

There are no CWT programs in place to estimate harvests in the Chickamin, Blossom and Keta rivers. As a result, mature-run equivalent exploitation rates from the nearby Neets Bay, Deer Mountain, and Whitman Lake hatcheries along with those seen in the Unuk River, minus any terminal hatchery harvests, are used as surrogate values. These hatcheries use the Chickamin River as a brood source and are available to harvest as rearing and mature fish in SEAK. Over this same period, exploitation rates on the Chickamin River stock have never exceeded the threshold reference line and have averaged just over one-half the threshold reference value (Figure 3.3.1.3.3).

Since 1983, harvest rates on for the Blossom and Keta River stocks have never exceeded their threshold reference values and on average have been about two-thirds of their threshold reference values (Figure 3.3.1.3.4, Figure 3.3.1.3.5).

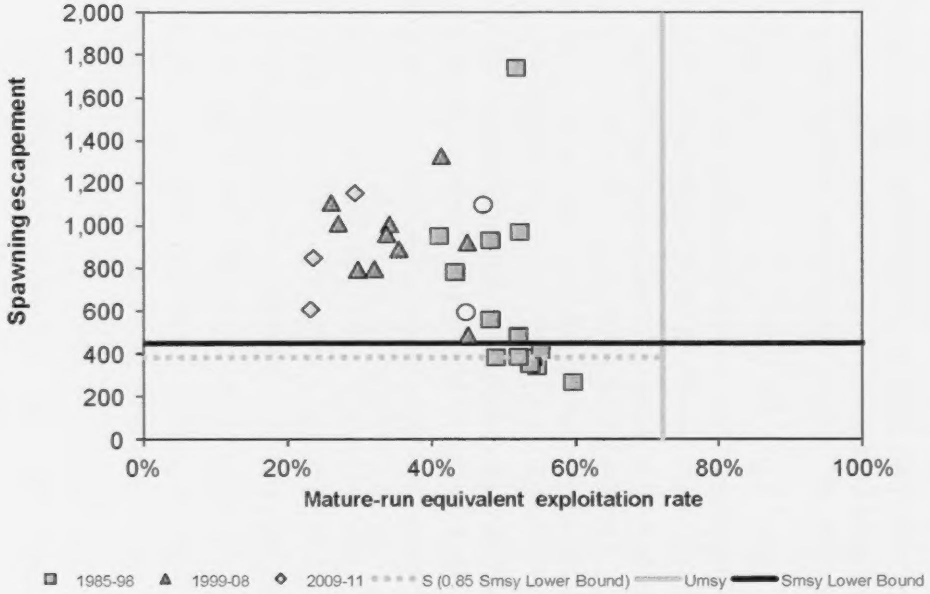

*Figure 3.3.1.3.3.–Mature-run equivalent exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement by CY for the Chickamin River stock of Chinook salmon, 1983–2011.*

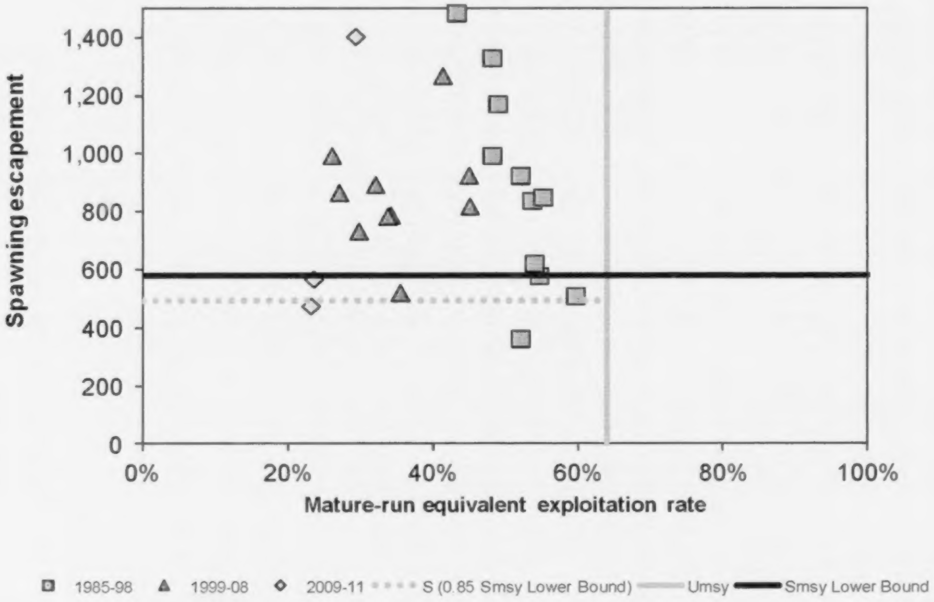

*Figure 3.3.1.3.4.–Mature-run equivalent exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement by CY for the Blossom River stock of Chinook salmon, 1983–2011.*

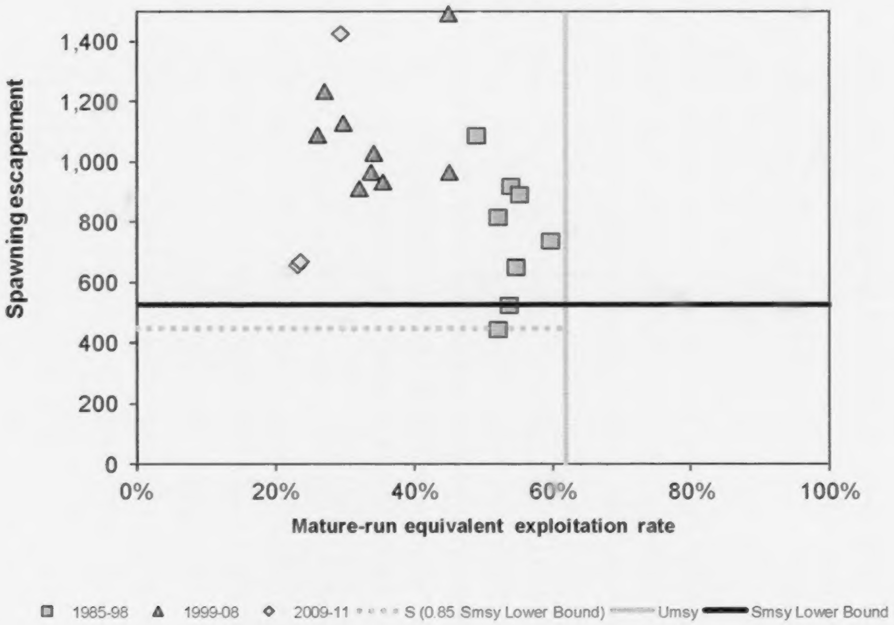

*Figure 3.3.1.3.5.–Mature-run equivalent exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement by CY for the Keta River stock of Chinook salmon, 1983–2011.*

## 3.3.2 Canadian Stocks

### 3.3.2.1 *Northern British Columbia: Kitsumkalum River*

NBC stocks are part of the North/Central British Columbia stock group, which has the Yakoun, Nass, and Skeena escapement indicators in NBC. Currently, none of these stocks have CTC escapement goals. The Kitsumkalum River is an exploitation rate indicator stock in the Lower Skeena River; it has produced high quality escapement estimates each year since 1984. This stock has had a very low level of enhancement for the CWT indicator stock targets (mean enhanced contribution = 3.4%, range = 0.4%–9.4%, return years 1985–2012). McNicol (1999) reviewed these data and estimated the stock-recruit relationship, which was updated by Parken et al. (2006). Marine survival was generally below average for brood years 1988 to 1996, and has varied around average since then (Figure 3.3.2.1.1). The cumulative exploitation rates have been below the threshold reference line in all but one year and escapements have exceeded $S_{MSY}$ in all but three years (Figure 3.3.2.1.2). In most years, the stock was in the safe zone.

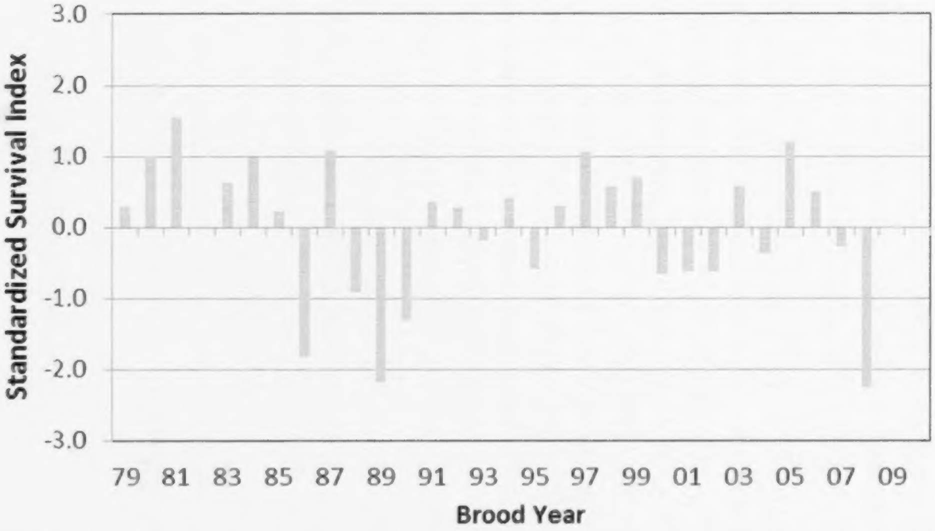

*Figure 3.3.2.1.1.–Marine survival index (standardized to a mean of zero) for the Kitsumkalum River stock of Chinook salmon, 1979–2007 brood years. Brood year 1982 was not represented by CWTs, thus no datum is available.*

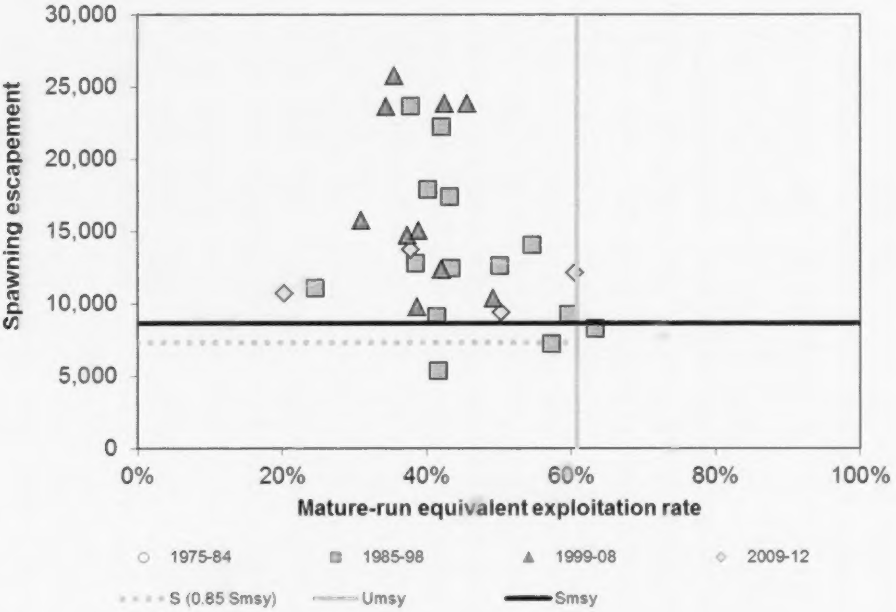

*Figure 3.3.2.1.2.–Mature-run equivalent exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement by CY for the Kitsumkalum River stock of Chinook salmon, 1985–2011.*

### 3.3.2.2 *Central British Columbia: Atnarko River*

Central British Columbia stocks are part of the North/Central British Columbia stock group, which has the Dean and Atnarko river escapement indicators in Central BC. Currently, none of these stocks have CTC escapement goals. The Atnarko River is an exploitation rate indicator stock in Area 8 that has escapement estimates produced by MR and a three-method average since 1975. This stock has had a high level of enhancement (Figure 3.3.2.2.1). Hatchery contribution has averaged 34% in Atnarko escapement from 1990 to 2012 and 27% over the last 12 years. The largest contributions occurred in the mid-1990s, reaching 67% in 1996. The recent increase in hatchery contribution is partly due to the implementation of yearling releases in addition to the sub-yearling releases of previous years. Adjustments have not been made to remove hatchery fish in order to make inferences for unenhanced stocks in Central BC. A stock-recruitment relationship has not been generated for this stock yet, thus the reference lines were estimated using habitat-based methods (Parken et al. 2006). Marine survival was generally above average for brood years 1988 to 1995, and has varied around average since then (Figure 3.3.2.2.2). The cumulative exploitation rates have been below the threshold reference line and escapements have exceeded $S_{MSY}$ in all years (Figure 3.3.2.2.3). The stock was in the safe zone in all years.

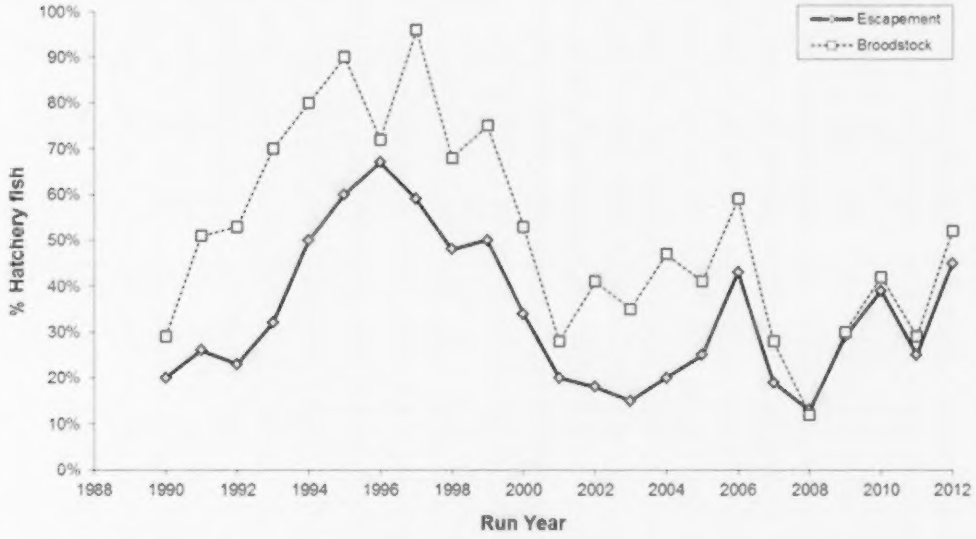

*Figure 3.3.2.2.1.–The percentage of first generation hatchery origin Chinook salmon in the Atnarko River escapement and in the hatchery broodstock, 1990–2012.*

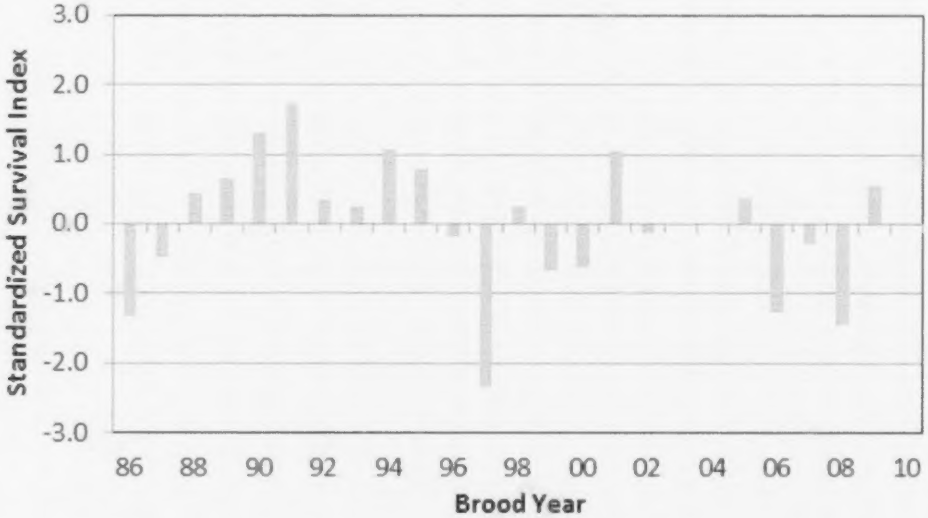

*Figure 3.3.2.2.2.–Marine survival index (standardized to a mean of zero) for sub-yearling releases of the Atnarko River stock of Chinook salmon, 1986–2009 brood years. Brood years 2003 and 2004 were not represented by CWTs, thus no data are available.*

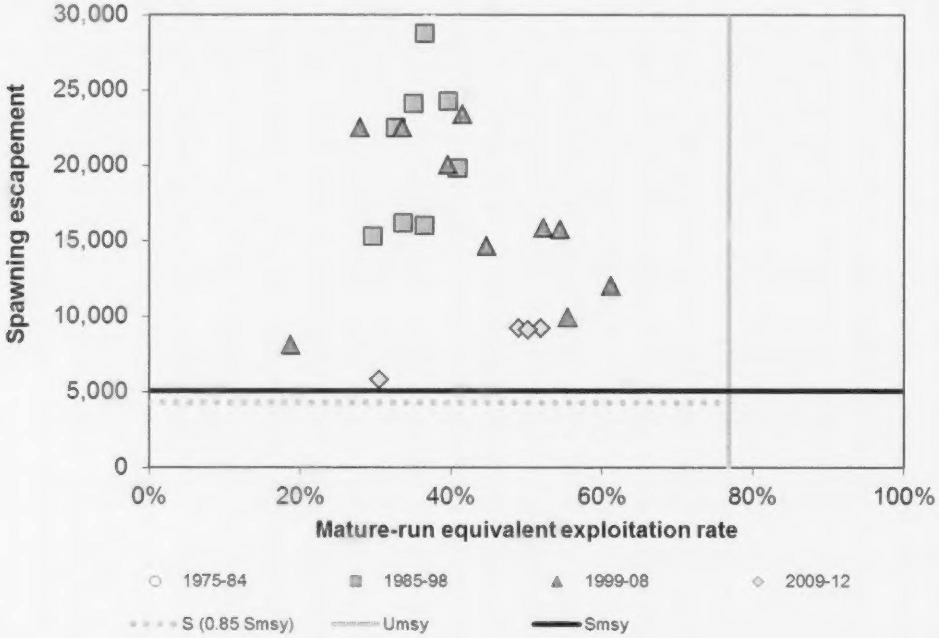

*Figure 3.3.2.2.3.–Mature-run equivalent exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement by CY for the Atnarko River stock of Chinook salmon, 1990–2012.*

### 3.3.2.3 *Lower Strait of Georgia: Cowichan River*

The LGS natural stock group has the Cowichan and Nanaimo river escapement indicators. Currently, only the Cowichan has a CTC escapement goal. A habitat-based estimate of $S_{MSY}$ is available for the Nanaimo River; however, the exploitation rate indicator program was discontinued after brood year 2004. The Cowichan River is an exploitation rate indicator stock that has escapement estimates produced by fence (weir) and MR methods. This stock has had a high level of enhancement (Figure 3.3.2.3.1), which influences the representativeness of this stock for others in LGS. Hatchery contribution averaged 24% in the escapement from 1982 to 2011 and 29% over the last 12 years. The largest contribution occurred in 2002 reaching 59%. Tompkins et al. (2005) reviewed these data and estimated the stock-recruit relationship. Marine survival was generally above average for brood years 1985 to 1992, was below average from 1993 to 2008, and slightly above average from 2009 to 2010 (Figure 3.3.2.3.2). The cumulative exploitation rates have been above the threshold reference line in 80% of the years and escapements have been below $S_{MSY}$ since 1997 (Figure 3.3.2.3.3). The stock has rarely been in the safe zone of the synoptic plot, only once during the last 25 years, with most of the recent years in the high risk zone. The stock experiences the highest exploitation of the stocks examined in Section 3.

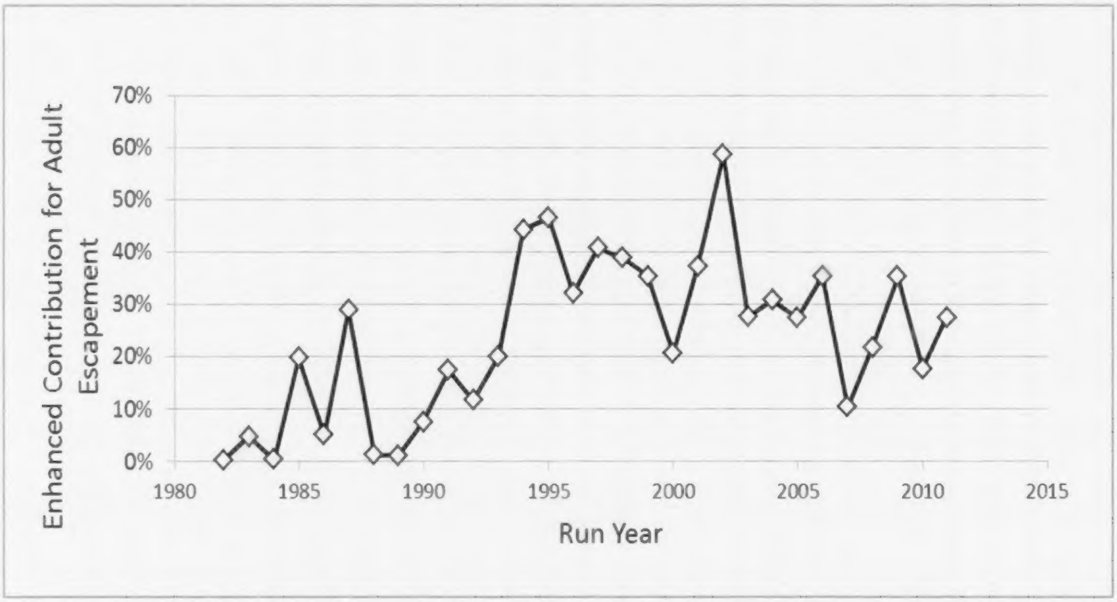

*Figure 3.3.2.3.1.–The percentage of first generation hatchery origin Chinook salmon in the Cowichan River adult escapement, 1982–2011.*

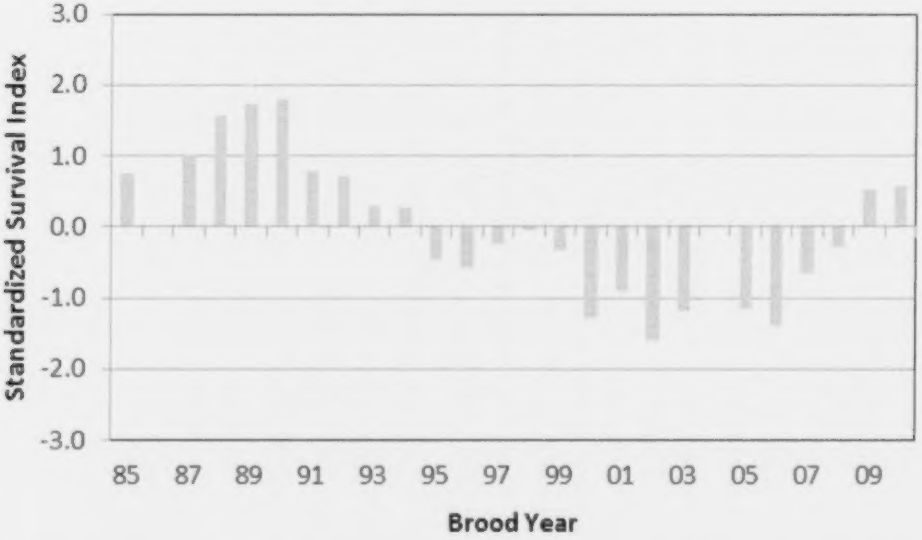

*Figure 3.3.2.3.2.–Marine survival index (standardized to a mean of zero) for the Cowichan River stock of Chinook salmon, 1985–2010 brood years. Brood years 1986 and 2004 were not represented by CWTs, thus no data are available.*

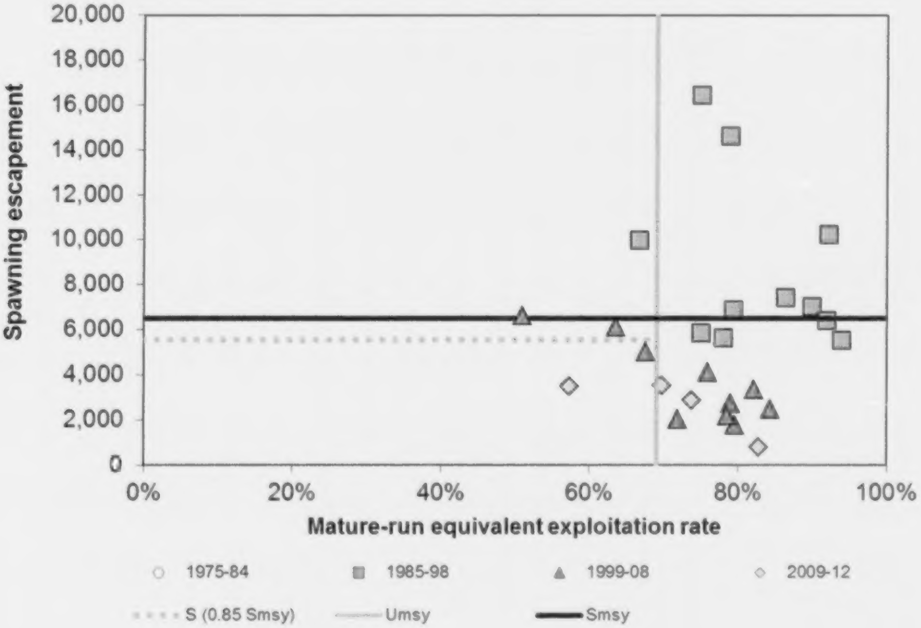

*Figure 3.3.2.3.3.–Mature-run equivalent exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement by CY for the Cowichan River stock of Chinook salmon, 1988–2012.*

### 3.3.2.4 *Fraser River Stocks*

Within the Fraser River, three of five escapement indicator stocks are represented currently by exploitation rate indicator stocks. Fraser River spring run age 1.2 are represented by the Nicola River, Fraser River summer run age .3 are represented by the Lower Shuswap River, and Fraser River late run are represented by the Harrison River. Fraser River spring run age 1.3 and Fraser River summer run age 1.3 are not currently represented by CWT-based indicator stocks.

#### 3.3.2.4.1 Fraser River Spring Run Age 1.2: Nicola River

The Fraser River spring run age-1.2 stocks are small-bodied, early-maturing stocks that spawn in tributaries to the Lower Thompson River, Louis Creek in the North Thompson River, and Bessette Creek in the South Thompson River. Currently, there are no CTC-approved escapement goals for this group and the reference lines were estimated from habitat-based methods (Parken et al. 2006). Harvest occurs almost exclusively during the return migration, while passing through approach fisheries and within the gauntlet of Fraser River fisheries. Escapements declined steeply between 2003 and 2009, and currently this is a stock group of concern for Canadian fishery planning. The Nicola River indicator stock has had a high level of enhancement, which influences its representativeness for other unenhanced stocks. Hatchery contribution averaged 29% for the 1987 to 2012 escapement and 20% over the last 12 years. The largest contribution was 60% in 1999 (Figure 3.3.2.4.1.1).

The Nicola River stock has been in either the safe or low escapement and low exploitation zones of the synoptic plot in all years. Since 2009, the stock has been in the low escapement and low exploitation zone in all years (Figure 3.3.2.4.1.2). The recent low escapements and low exploitation rates indicate that smolt survival, freshwater survival, or their interaction have contributed to low production. This pattern showing a shift to a below average survival regime beginning with brood year 2000 appears similar to the pattern described previously for the outside rearing stocks in Alaska. Cohorts that entered the ocean in 2005 and 2007, and returned in 2007 and 2009, faired particularly poorly. A pattern of alternating years of very poor escapements has persisted due to the weak returns from those smolts despite increased conservation measures. Survivals decreased steeply with the 2000 brood (2002 ocean entry) and remained below average subsequently, with the modest exception of 2006 brood (2008 ocean entry; Figure 3.3.2.4.1.3). The very low survival for the 1992 brood year was caused by a Myxobacteria infection at Spius hatchery, and the survival for the 1994 brood year was affected by high pre-spawn mortality in 1998 (not measured). Rebuilding will require a sustained return to more favorable survival conditions.

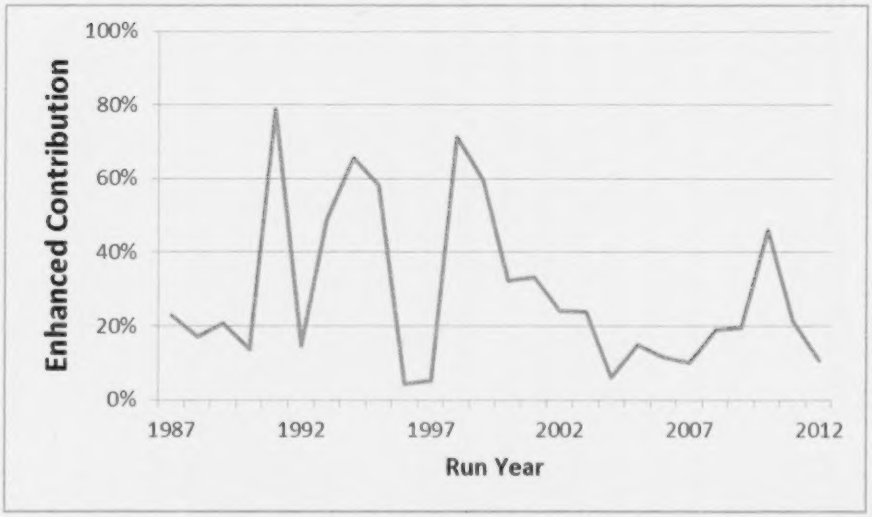

*Figure 3.3.2.4.1.1.–The percentage of first generation hatchery origin Chinook salmon in the Nicola River escapement, 1987–2012.*

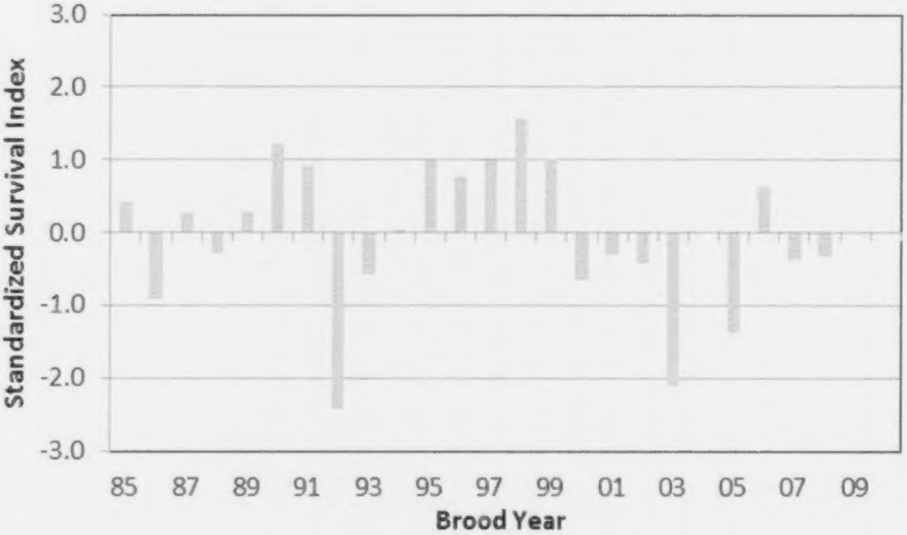

*Figure 3.3.2.4.1.2.–Marine survival index (standardized to a mean of zero) for the Nicola River stock of Chinook salmon, 1985–2008 brood years.*

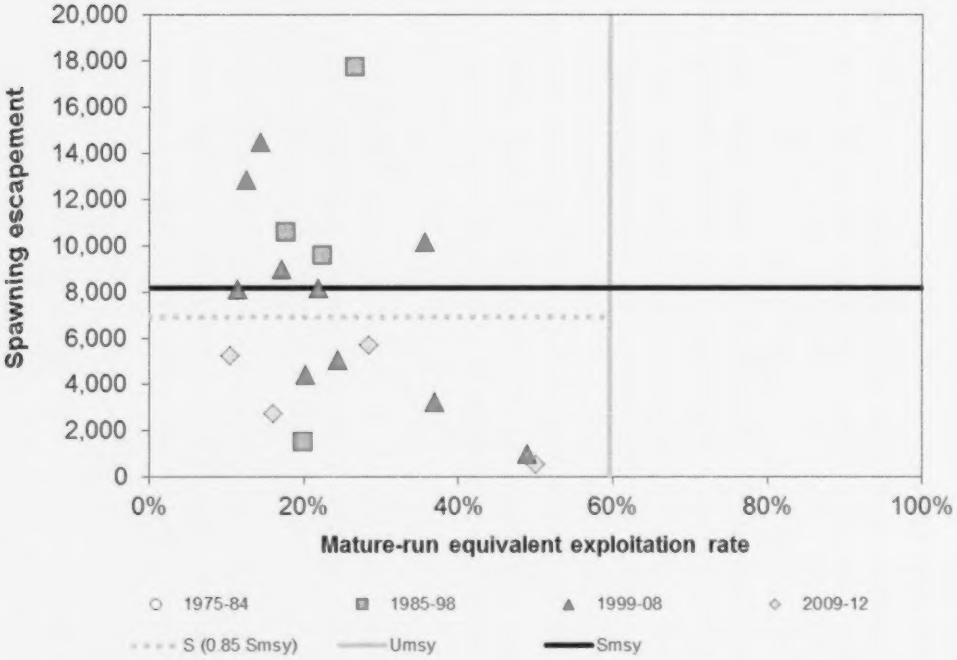

*Figure 3.3.2.4.1.3..–Mature-run equivalent exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement by CY for the Nicola River stock of Chinook salmon, 1995–2012.*

### 3.3.2.4.2 Fraser River Summer-run Age .3: Lower Shuswap

The Fraser River summer run age-.3 stocks are far north migrating, ocean-type stocks that spawn in Maria Slough (Lower Fraser River), the Lower Thompson River, and South Thompson River and tributaries. These fish remain upon the continental shelf for their entire marine residence and are vulnerable to harvest throughout that period and during return migration, in both marine and Fraser River fisheries. Escapements to this stock group increased from about 25,000 through the 1980s to more than 100,000 between 2006 and 2011, peaking in 2010 at an estimated 156,600, and declining steeply in 2012 to about 48,000. Currently, there are no CTC-approved escapement goals for this group and the reference lines were estimated from habitat-based methods (Parken et al. 2006). The Lower Shuswap River indicator program provides survival and exploitation information. This stock has had a mean enhancement level of 7% from 1987 to 2012 (range = 1%–20%), and averaged 6% over the last 12 years. Survivals appear poor for the 2008 and 2009 brood years (both incomplete cohorts), contributing to the lower abundance in 2012 Figure 3.3.2.4.1.1). The cumulative exploitation rates have been below the threshold reference line in all but two years and escapements have exceeded $S_{MSY}$ in all but two years. The Lower Shuswap CWT stock has been in the healthy zone of the synoptic plot in all but four years (Figure 3.3.2.4.1.2). Since implementation of the 2009 Agreement, three years were in the safe zone and the other year was in the low escapement and low exploitation zone.

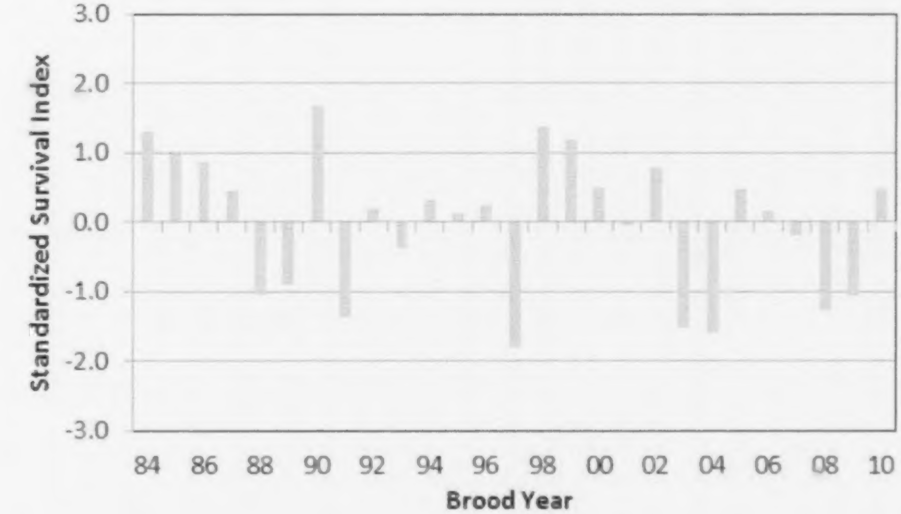

*Figure 3.3.2.4.2.1.–Marine survival index (standardized to a mean of zero) for the Lower Shuswap River stock of Chinook salmon, 1984–2010 brood years.*

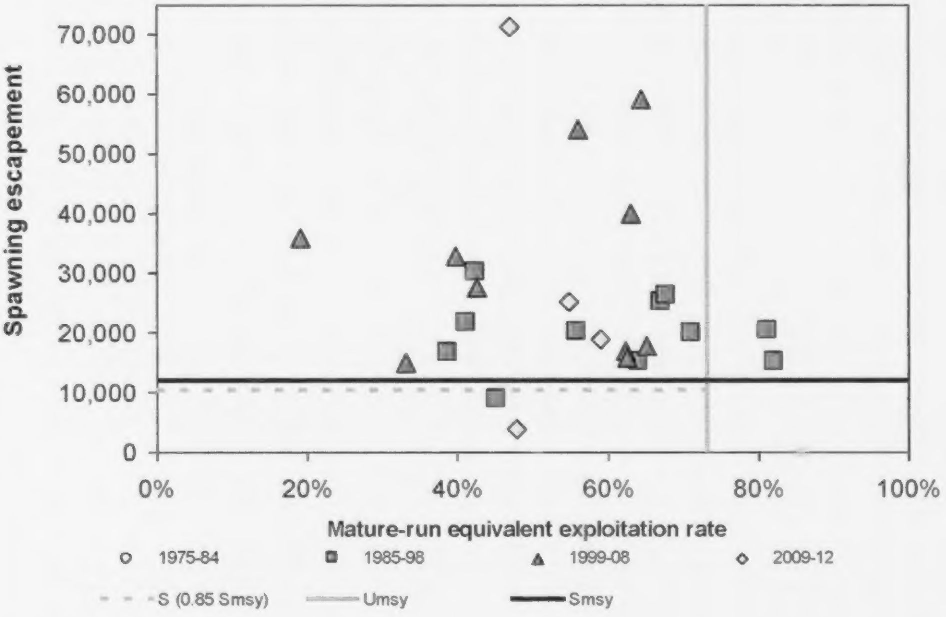

*Figure 3.3.2.4.2.2.–Mature-run equivalent exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement by CY for the Lower Shuswap River stock of Chinook salmon, 1989–2012.*

### 3.3.2.5 *Fraser Late: Harrison River*

The Fraser late stocks are white-fleshed fall-run Chinook salmon, originating from the Harrison River downstream of Harrison Lake in the Lower Fraser River. Juveniles migrate to the Fraser estuary immediately after emergence and remain in the estuary area for up to six weeks before moving into the Strait of Georgia. Their ocean distribution is principally in the Salish Sea, WCVI and Coastal Washington, where they are vulnerable to fisheries throughout their ocean residence. The stock group was represented originally by the Chilliwack River exploitation rate indicator stock, but recently data have been reported for the Harrison River indicator stock. The enhanced contribution has been low at the Harrison River over the last 12 years (mean = 3.7%). With a few exceptions, survivals have been below average since the early 1990s (Figure 3.3.2.5.1), and escapements have been below the goal range for three of the past seven seasons. The synoptic plot shows the stock with exploitation rates higher than the reference line in the majority of years from 1985 to 1998, with two years in the high risk zone but only one year in the safe zone (Figure 3.3.2.5.2). Cumulative exploitation rates were reduced under the 1999 Agreement, with the majority of years having exploitation rates less than $U_{MSY}$. Exploitation rates were further reduced under the 2009 Agreement, with only two years in the safe zone and the others in the buffer zone or the low escapement and low exploitation zone. The recent low escapements and low exploitation rates indicate that smolt survival, freshwater survival or their interaction have contributed to low production.

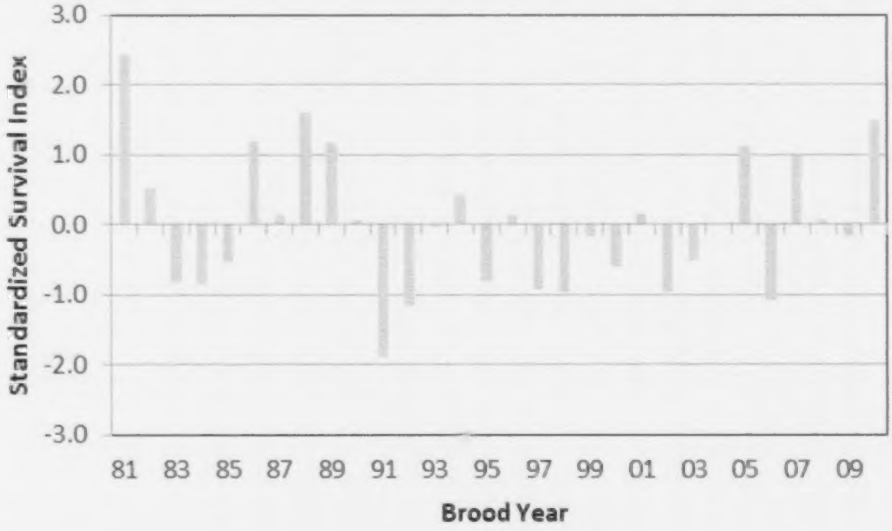

*Figure 3.3.2.5.1.–Marine survival index (standardized to a mean of zero) for the Harrison River stock of Chinook salmon, 1981–2010 brood years. No data are available for brood year 2004.*

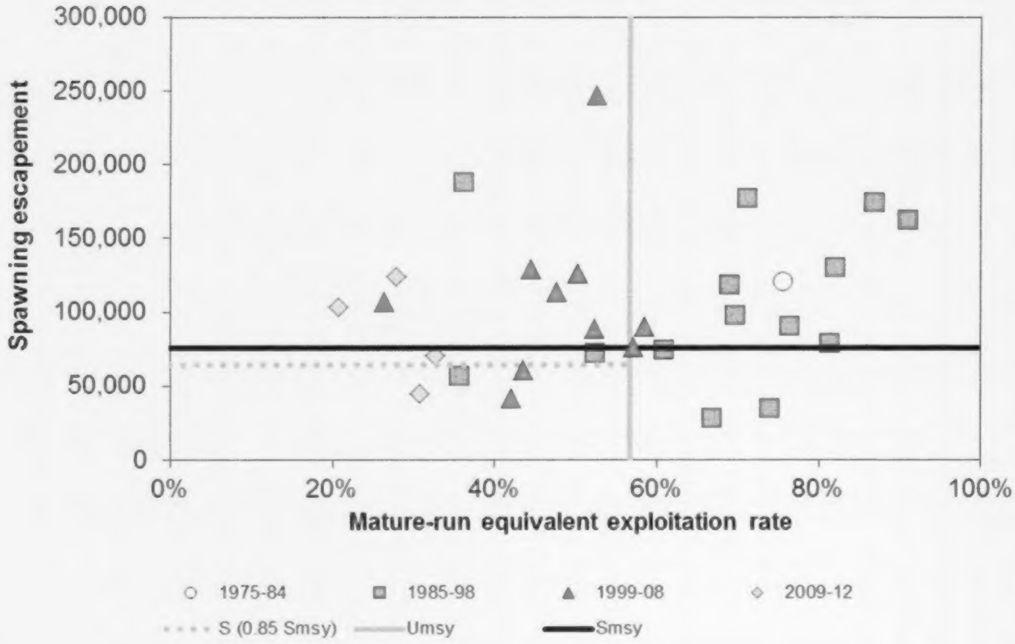

*Figure 3.3.2.5.2.–Mature-run equivalent exploitation rate, spawning escapement, and threshold reference lines for exploitation rate and spawning escapement by CY for the Harrison River stock of Chinook salmon, 1984–2012.*

## 3.3.3 Puget Sound, Coastal Washington, Columbia River, and Coastal Oregon Stocks

### 3.3.3.1 *Puget Sound*

Puget Sound stocks are a mixture of natural- and hatchery-origin production of spring run and summer/fall run fish. This mix of hatchery- and natural-origin production influences both the fisheries within Puget Sound, where terminal fisheries target abundant hatchery stocks, as well as the escapement to the spawning grounds, which contains many hatchery strays in some cases. Consequently, assessing long-term trends of natural stocks in Puget Sound can prove difficult because of the interaction of hatchery- and natural-origin production in fishery and escapement accounting. Hatchery programs in Puget Sound have annually released between about 23 million (1976) to over 56 million (1989) Chinook salmon (Figure 3.3.3.1.1). Since Puget Sound Chinook salmon were listed as threatened status under the U.S. ESA in 1999, hatchery production has averaged about 33 million releases annually. Although Puget Sound hatchery programs historically emphasized production for fisheries alone, many of today's programs are also associated with endangered species recovery or wild broodstock CWT indicator programs.

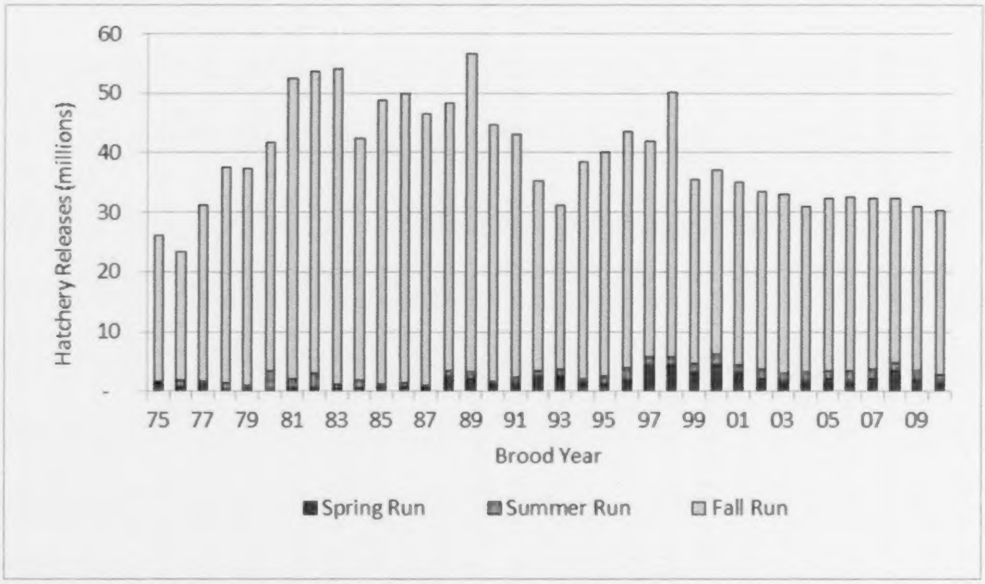

*Figure 3.3.3.1.1.–Chinook salmon released from Puget Sound hatcheries, 1975–2010 brood years.*

Spring run stocks in Puget Sound are both ocean-type (age-0 fingerling out-migrants) and stream-type (age-1 yearling out-migrants) life history. Key spring stocks are the PSC escapement indicators in the Nooksack and Skagit rivers, as well as the White River (PSC CWT indicator), with associated hatchery programs in each. Natural escapement in the Nooksack River is predominately hatchery-origin fish, whereas on the Skagit River, hatchery-origin fish are rarely seen in the spawning areas. Summer/fall run stocks are predominately ocean-type fish and this run-timing group comprises the majority of Chinook salmon production from Puget Sound. Skagit River summer/fall Chinook salmon is the largest stock in Puget Sound, and consists almost exclusively of natural-origin fish. The Skagit and Stillaguamish rivers have PSC CWT exploitation rate indicator stocks (Skagit and Stillaguamish rivers) and supplementation programs (Stillaguamish only) that use broodstock collected from the spawning grounds. Basins with large hatchery programs include the Snohomish and Green PSC escapement indicators as well as the Samish, Puyallup, Nisqually and Skokomish rivers. In addition, net-pen programs in Bellingham and Tulalip bays release large number of juvenile Chinook salmon.

Estimates of total production for the Puget Sound PSC escapement indicator stocks have not been made in part because of the lack of long-term representative tag groups for the natural stocks (except Green River). The trend in the escapement of Puget Sound summer/fall PSC escapement indicator stocks is driven primarily by the status of Skagit River summer/fall Chinook salmon. Consequently, the status and trend of Puget Sound summer/fall Chinook salmon will track with the abundance of Skagit River fish since in most years the abundance of Skagit River fish is higher than the sum of the escapement of the other PSC indicator stocks. This is especially true when the escapement of Skagit River Chinook salmon averaged 17,900 from 2000 to 2006, and exceeded 20,000 from 2004 to 2006. For the period of 1975 to 2012, the aggregate escapement of Puget Sound summer/fall indicator stocks has ranged from a low of about 12,000 fish in 2009 and 2011 to a high of 45,000 in 2004 (Figure 3.3.3.1.2). None of the Puget Sound Chinook salmon stocks have CTC-approved escapement goals. The aggregate escapement goal calculated by summing the agency upper management goals for these stocks is 27,480. This escapement was achieved in 11 years (30%) during the 1975 to 2012 time period.

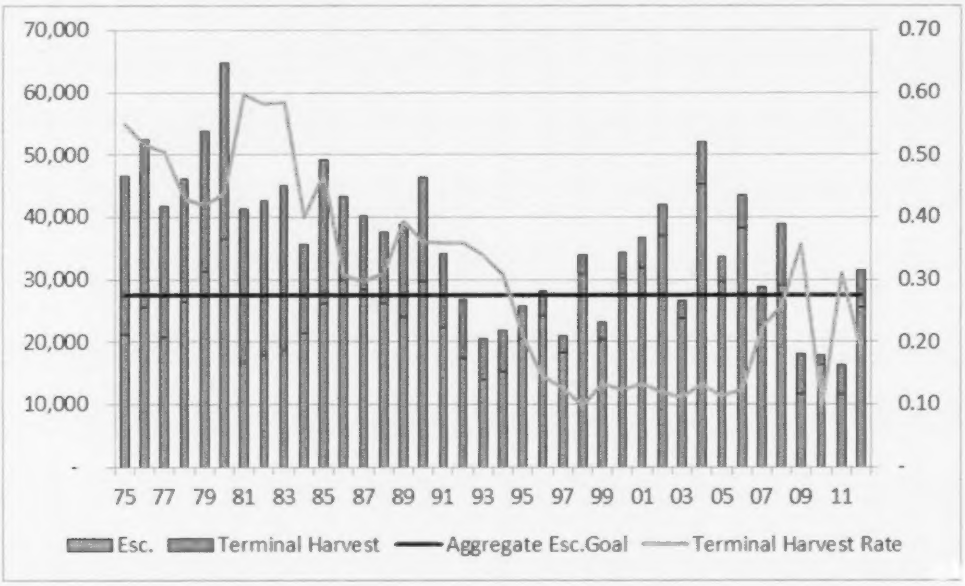

*Figure 3.3.3.1.2.–Escapement, aggregate escapement goal and terminal fishery harvest for the aggregate of Puget Sound summer/fall Chinook salmon PSC escapement indicator stocks.*

The harvest rate in the terminal fisheries for these stocks has generally declined from between 40% and 50% fishing mortality in the early 1980s to about 10% at the time of listing under the ESA in 1999. Since 1999, the terminal fishery harvest precluded meeting the aggregate escapement goal in 2008 and 2012. In most years, the majority of the terminal fishery harvest has depended on the status of Green River Chinook salmon and to a lesser extent on Skagit River fish. Directed terminal fisheries do not occur on Snohomish River, Stillaguamish River, and Lake Washington Chinook salmon.

The long-term escapement trends for Puget Sound Chinook salmon stocks cannot be identified with certainty because of the inability to assess total production of natural stocks in Puget Sound, coupled with the changes in fishery patterns and hatchery production over the 1975 to 2012 time period. Data limitations notwithstanding, it is still possible to make some generalizations about the current status of Puget Sound escapement indicators based on recent abundance trends at both the aggregate and individual population levels. Spring Chinook salmon exhibit variable trends; Nooksack River spring Chinook salmon show recent decline, whereas Skagit River spring Chinook salmon escapements have remained relatively stable. Overall, summer/fall escapements have declined notably from near-peak levels in the recent decade (Figure 3.3.3.1.3) and in a manner commensurate with the escapement declines of the

1990s that led to ESA listing. Examined at the individual stock level, however, some variation on this general theme emerges (Figure 3.3.3.1.4). Trends for summer-fall indicator stocks in the Green, Skagit, and Snohomish rivers generally mirror the aggregate pattern (i.e., recent decline), whereas Stillaguamish and Lake Washington tributary populations exhibit stable escapement trajectories. Although it is important to acknowledge the influence of the time period choice on conclusions about recent abundance trends (i.e., near-record escapements were seen for many Puget Sound populations in early 2000s), the observation of low escapements in multiple recent years (2009–2011) for three of the biggest populations suggests a depressed state overall. It should be noted, however, that escapements generally increased in 2012, possibly indicating a period of higher abundances. Future assessments of escapement trends should attempt to separate hatchery strays from natural-origin spawners, where data permit.

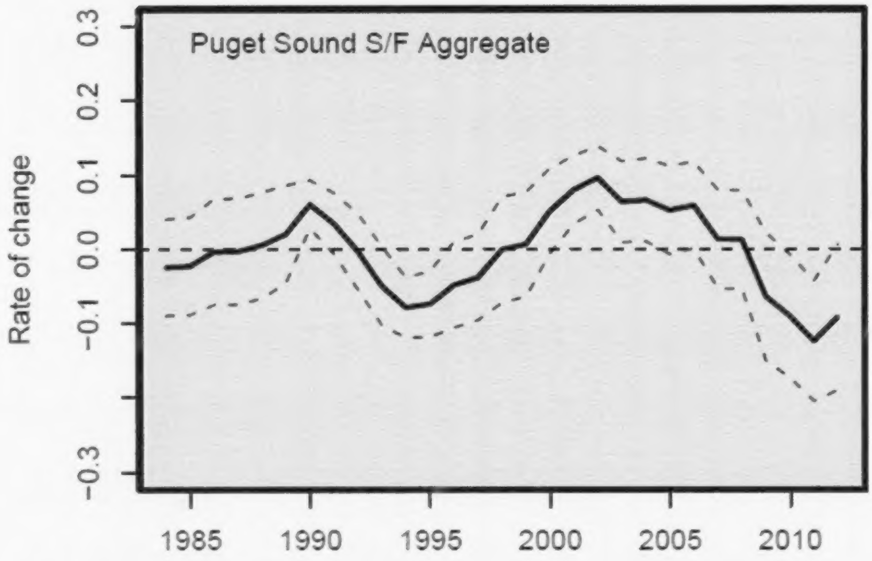

*Figure 3.3.3.1.3.–Retrospective evaluations of abundance trends for the historical record of aggregate escapement for Puget Sound summer/fall Chinook salmon indicator stocks.*

*Note: The y-axis Rate of change is the slope from a $\log_e$(escapement) vs. year regression for the 10-year period ending in the year given on the x-axis. Solid lines denote point estimates for $\log_e$(esc.) vs. time slope parameters, whereas dashed lines denote upper and lower confidence bounds (95%) on these values. Points lying below the zero horizontal reference line indicate years preceded by recent decline, whereas those above imply recent escapement increase.*

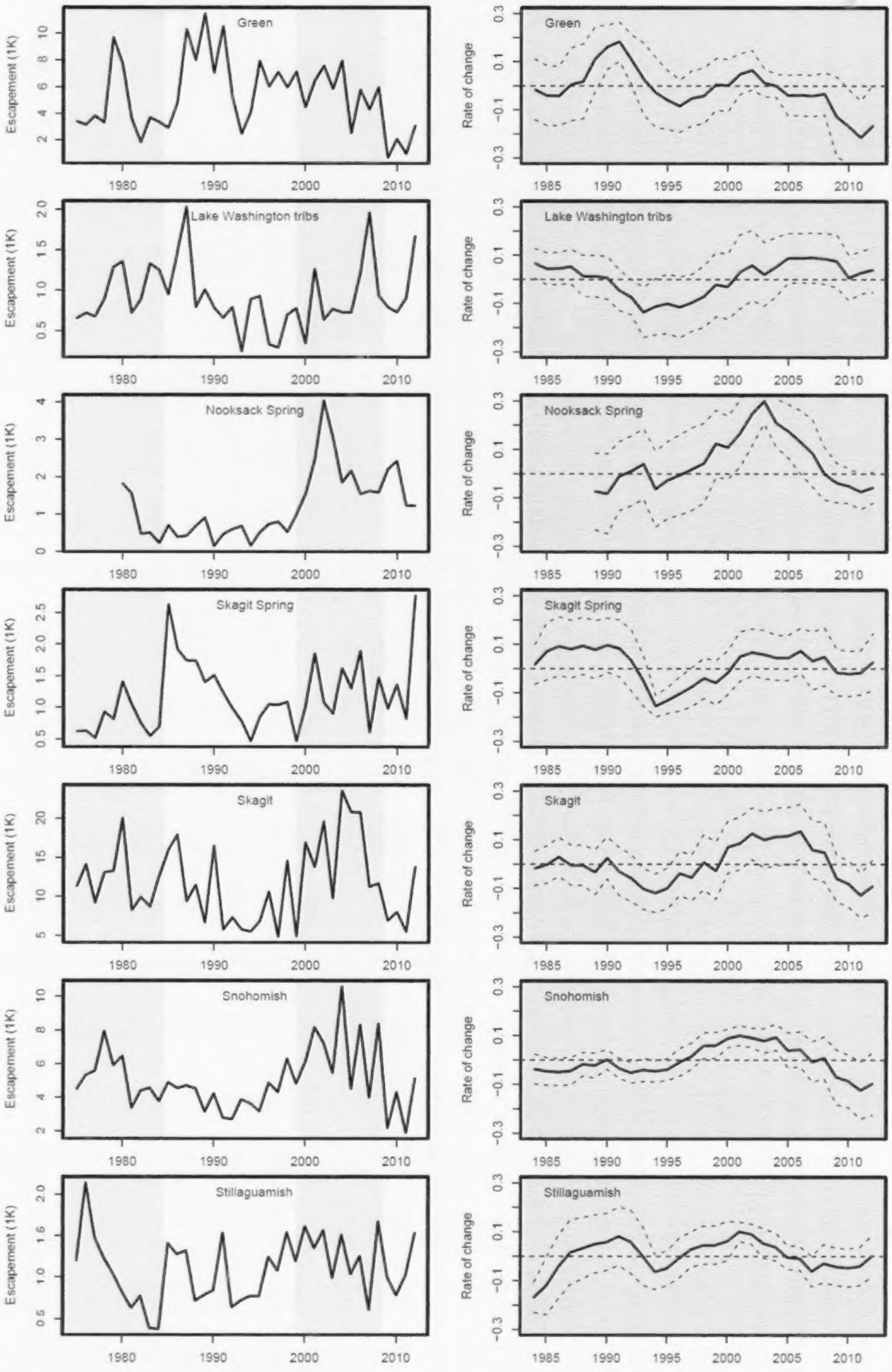
Green
Lake Washington tribs
Nooksack Spring
Skagit Spring
Skagit
Snohomish
Stillaguamish
Escapement (1K)
Rate of change
1980
1990
2000
2010
1985
1995
2005
0.3
0.1
-0.1
-0.3

*Figure 3.3.3.1.4.–(Previous Page) Escapement time series plots (left column) and retrospective evaluations of abundance trends for the historical record of escapements (right column) for Puget Sound Chinook salmon indicator stocks.*

*Note: n left column figures, the alternating gray shaded areas denote periods corresponding to pre-treaty (<1985) and post-treaty agreement periods (1985–1999, 1999–2008, 2009+). In the right column figures, the y-axis Rate of change is the slope from a $log_e$(escapement) vs. year regression for the ten-year period ending in the year given on the x-axis. Solid lines denote point estimates for $log_e$(esc.) vs. time slope parameters, whereas dashed lines denote upper and lower confidence bounds (95%) on these values. Points lying below the zero horizontal reference line indicate years preceded by recent decline, whereas those above imply recent escapement increase. Unless specified, stocks are of summer/fall run timing.*

### 3.3.3.2 *Coastal Washington*

Coastal Washington is the only region in the state accessible to anadromous salmonids where Chinook salmon are not listed under the U.S. ESA. Consequently, salmon fishery management of the coastal Chinook salmon stocks in this region has one less regulatory framework to consider each year, but still has to balance conservation needs with state and tribal co-management, federal fishery management plans, and international agreement under the PST. Additionally, compared to Puget Sound, the confounding influence of hatchery production on trend assessments is considerably less.

The aggregate escapement of spring and summer Chinook salmon PSC escapement indicator stocks in the Queets, Quillayute, and Hoh rivers and Grays Harbor ranged from a low of 2,016 in 2007 to a high of 11,740 in 1989 (Figure 3.3.3.2.1). Since 1999, total escapement did not achieve the aggregate agency goal (sum of stock-specific goals) of 4,200 in 5 of the 14 years. Despite a declining terminal harvest rate that averaged only 13%, the escapement goal was met only twice in the last six years. Thus, in most years, terminal fisheries played a minimal role in determining whether or not the aggregate escapement goal was achieved. Given that the historical escapement record is punctuated by multiple periods of decline and subsequent increase (Figure 3.3.3.2.2), it is unclear whether the recent decline in returns is temporary or whether it will continue in the future. For individual stocks, Queets River spring/summer and Quillayute River summer Chinook salmon populations have not met escapement goals in the majority of years since 1999, and both the Hoh and Quillayute stocks exhibit escapement trends indicating a recent decline (Figure 3.3.3.2.3). There are no representative PSC indicator tag groups for these stocks. However, CWT groups were released from Sol Duc Salmon Hatchery in the Quillayute basin in the early 1990s and were discontinued for about 10 years before starting new tagging programs with the 2004 brood. Based on limited information from these tag groups that generally showed poor survival, the Quillayute stock has a northerly ocean catch distribution. Exploitation rates cannot be determined because recoveries are low and escapement area sampling appears inadequate in some years.

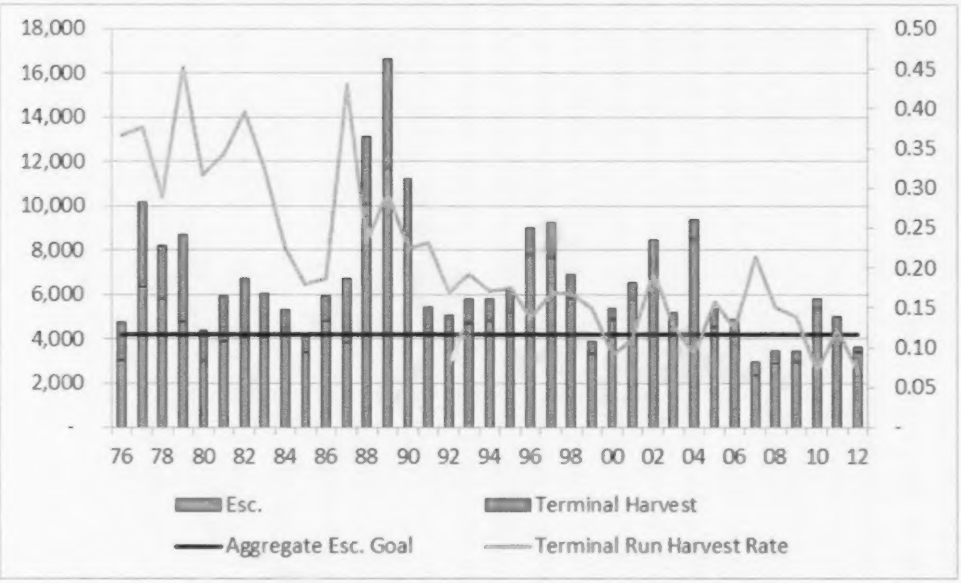

*Figure 3.3.3.2.1.–Escapement, aggregate escapement goal and terminal fishery harvest for the aggregate of Washington coastal spring/summer Chinook salmon PSC escapement indicator stocks.*

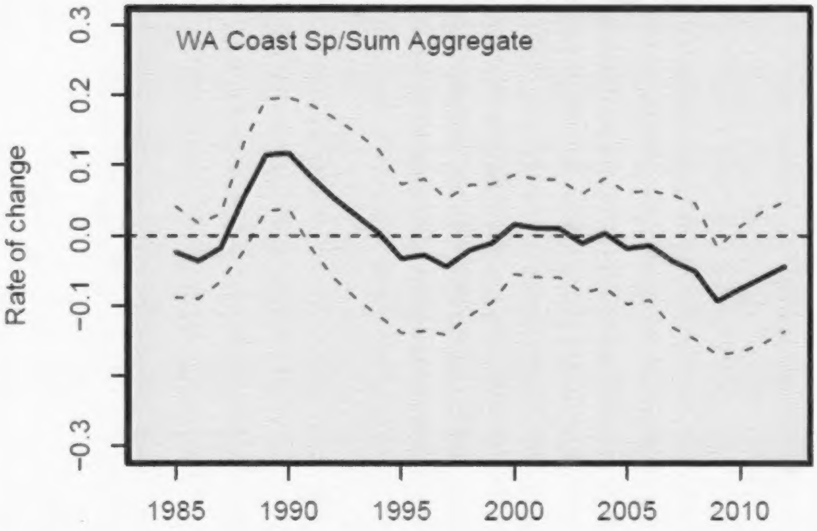

*Figure 3.3.3.2.2.–Retrospective evaluations of abundance trends for the historical record of aggregate escapement for Washington Coast spring/summer Chinook salmon indicator stocks.*

*Note: The y-axis 'Rate of change' is the slope from a log$_e$(escapement) vs. year regression for the 10-year period ending in the year given on the x-axis. Solid lines denote point estimates for log$_e$(esc.) vs. time slope parameters, whereas dashed lines denote upper and lower confidence bounds (95%) on these values. Points lying below the zero horizontal reference line indicate years preceded by recent decline, whereas those above imply recent escapement increase.*

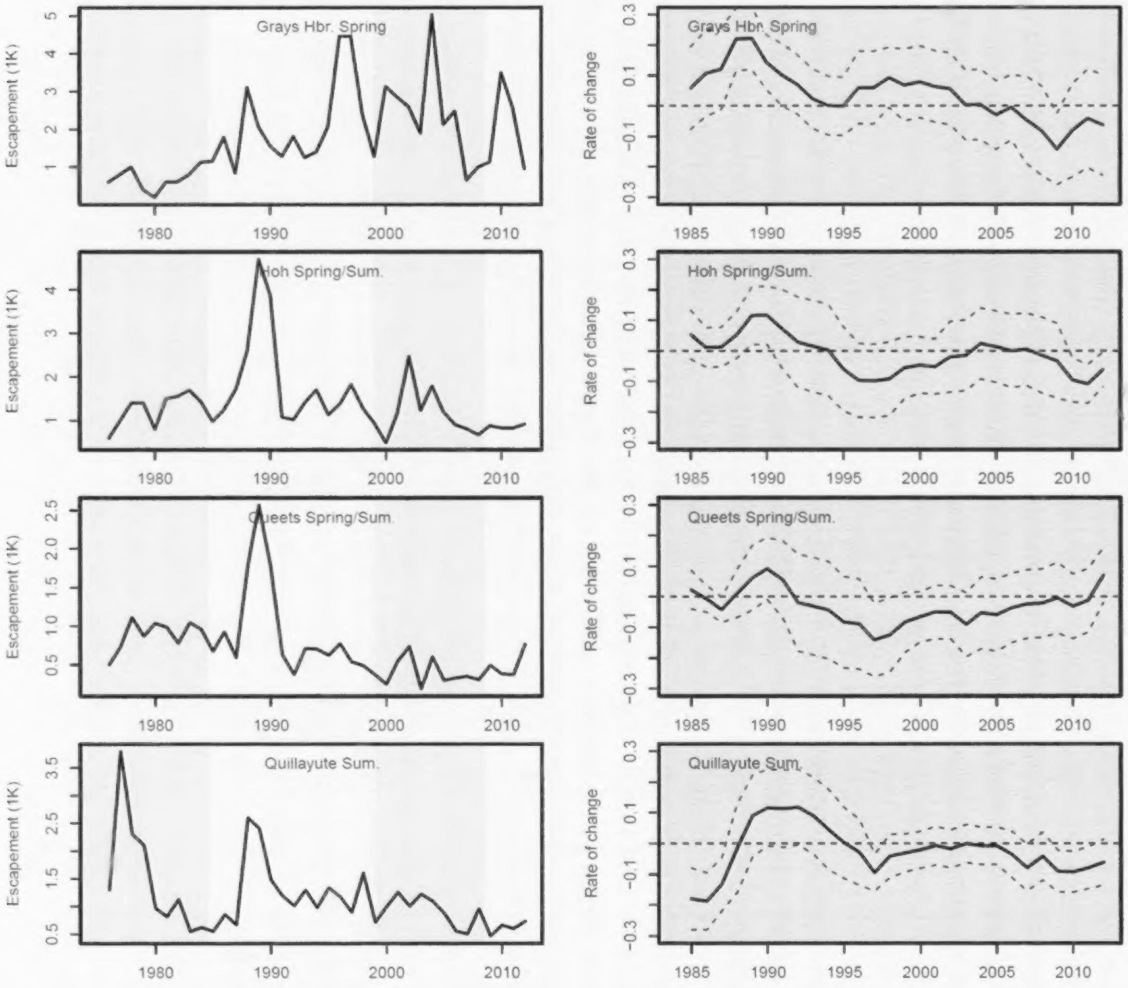

*Figure 3.3.3.2.3.–Escapement time series plots (left column) and retrospective evaluations of abundance trends for the historical record of escapements (right column) for Washington Coast Spring/Summer indicator stocks.*

*Note: In left column figures, the alternating gray shaded areas denote periods corresponding to pre-treaty (<1985) and post-treaty agreement periods (1985–1999, 1999–2008, 2009+). In the right column figures, the y-axis 'Rate of change' is the slope from a $\log_e$(escapement) vs. year regression for the 10-year period ending in the year given on the x-axis. Solid lines denote point estimates for $\log_e$(esc.) vs. time slope parameters, whereas dashed lines denote upper and lower confidence bounds (95%) on these values. Points lying below the zero horizontal reference line indicate years preceded by recent decline, whereas those above imply recent escapement increase.*

Coastal Washington fall Chinook salmon escapement indicators include Queets, Quillayute, and Hoh stocks that have CTC-approved escapement goals and the Hoko and Grays Harbor area stocks that only have agency management goals. Aggregate escapement has ranged from a low of 14,512 in 1983 to a high of 56,692 in 1988 (Figure 3.3.3.2.4). The aggregate escapement goal combining CTC-approved goals with the agency goals is 22,150. This escapement was achieved in 23 years or 62% of the 1975 to 2012 time period. Since 1999, the aggregate escapement goal has been achieved 57% of the time. Considering the most recent decade only, it appears that this aggregate of stocks is in decline relative to the high escapements of the early 2000s (Figure 3.3.3.2.5), although this is heavily influenced by the escapement trends for two of the larger stock components (Grays Harbor, Quillayute River). It should be noted, however, that phases of increasing/decreasing escapements appear to show a similar pattern for the stock group. Over the entire 1975 to 2012 time period, terminal harvest rates have varied substantially without a definitive trend and have averaged about 27% since 1999. With the exception of the Hoko stock, harvest in the terminal fisheries is a mixture of directed catch on Chinook salmon and incidental catch while targeting other species (Figure 3.3.3.2.6).

Unlike in Puget Sound where hatchery production is significant and widespread and can complicate natural stock accounting, fall Chinook salmon hatchery production is more limited on the Washington Coast and not extensive in the PSC indicator stock basins. Hatchery programs that currently release fall Chinook salmon in the PSC indicator stock basins include the Hoko Falls Hatchery that releases smolts for natural stock supplementation/CWT indicator stock purposes, Salmon River Fish Culture Hatchery in the Queets basin, and Humptulips Salmon Hatchery in the Grays Harbor watershed. Other significant programs outside of the PSC escapement indicator stock programs include releases from Makah National Fish Hatchery on Sooes Creek, Quinault National Fish Hatchery on Cook Creek in the Quinault basin, and Forks Creek Hatchery in Willapa Bay. All of these hatchery programs influence the management of terminal fisheries and the extent of directed harvest on fall run Chinook salmon.

Despite the presence of some trends in escapement, conclusions on stock status and population trend are speculative without a full run reconstruction (CWT-based) that can account for total production. A comprehensive run reconstruction has not been conducted for any coastal Washington stocks, although Queets stock is a logical candidate given the availability of data for the Queets CWT indicator group. Terminal area returns for the aggregate coastal fall stocks show a decline since the late 1980s and a relatively level trend since 1999. Ocean fishery impacts for these stocks can be estimated using the Queets CWT indicator tag group. From a simple fishery distribution basis, the portion of the Queets stock impacted in ocean fisheries shows no apparent trend and has averaged about 44% of the total accounting in all fisheries and escapement since 1985 (CTC 2012). Since ocean fishery impacts show no trend and terminal returns have declined since the late 1980s, it appears that total adult production has also declined. Further investigation and analysis is needed to confirm this generalization.

Queets CWT indicator tag groups were used to produce plots for a synoptic evaluation of the three coastal Washington fall Chinook salmon stocks with CTC-approved escapement goals—Queets, Quillayute, and Hoh rivers. Queets CWT groups were assumed to be representative of the exploitation and ocean distribution of Quillayute and Hoh stocks. All three stocks have active terminal fisheries with similar terminal fishery harvest rates, therefore, Queets CWTs are considered a suitable surrogate to estimate exploitation in the Quillayute and Hoh rivers.

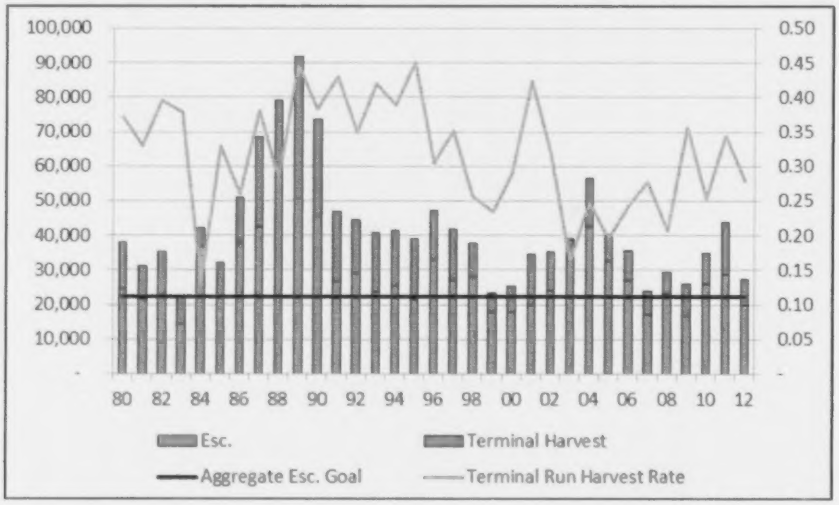

*Figure 3.3.3.2.4.–Escapement, aggregate escapement goal and terminal fishery harvest for the aggregate of Washington coastal fall Chinook salmon PSC escapement indicator stocks.*

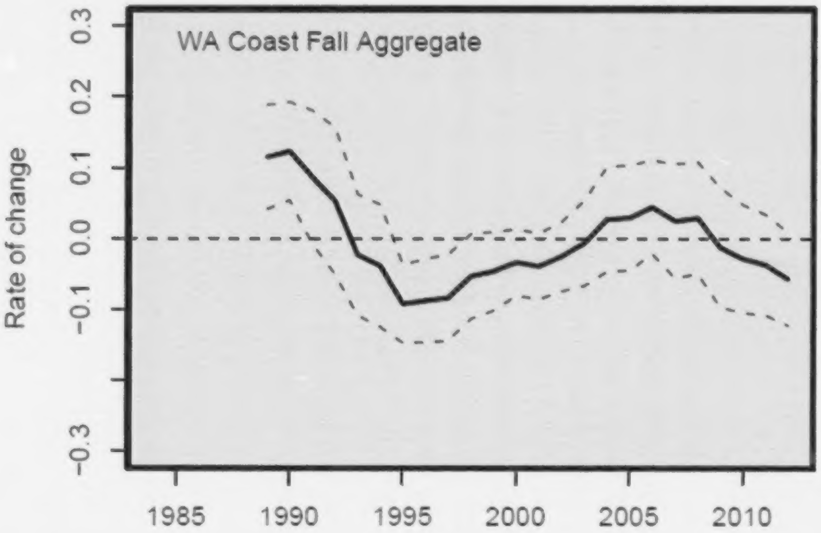

*Figure 3.3.3.2.5.–Retrospective evaluations of abundance trends for the historical record of aggregate escapement for Washington Coast Fall Chinook salmon indicator stocks.*

*Note: The y-axis Rate of change is the slope from a $\log_e$(escapement) vs. year regression for the 10-year period ending in the year given on the x-axis. Solid lines denote point estimates for $\log_e$(esc.) vs. time slope parameters, whereas dashed lines denote upper and lower confidence bounds (95%) on these values. Points lying below the zero horizontal reference line indicate years preceded by recent decline, whereas those above imply recent escapement increase.*

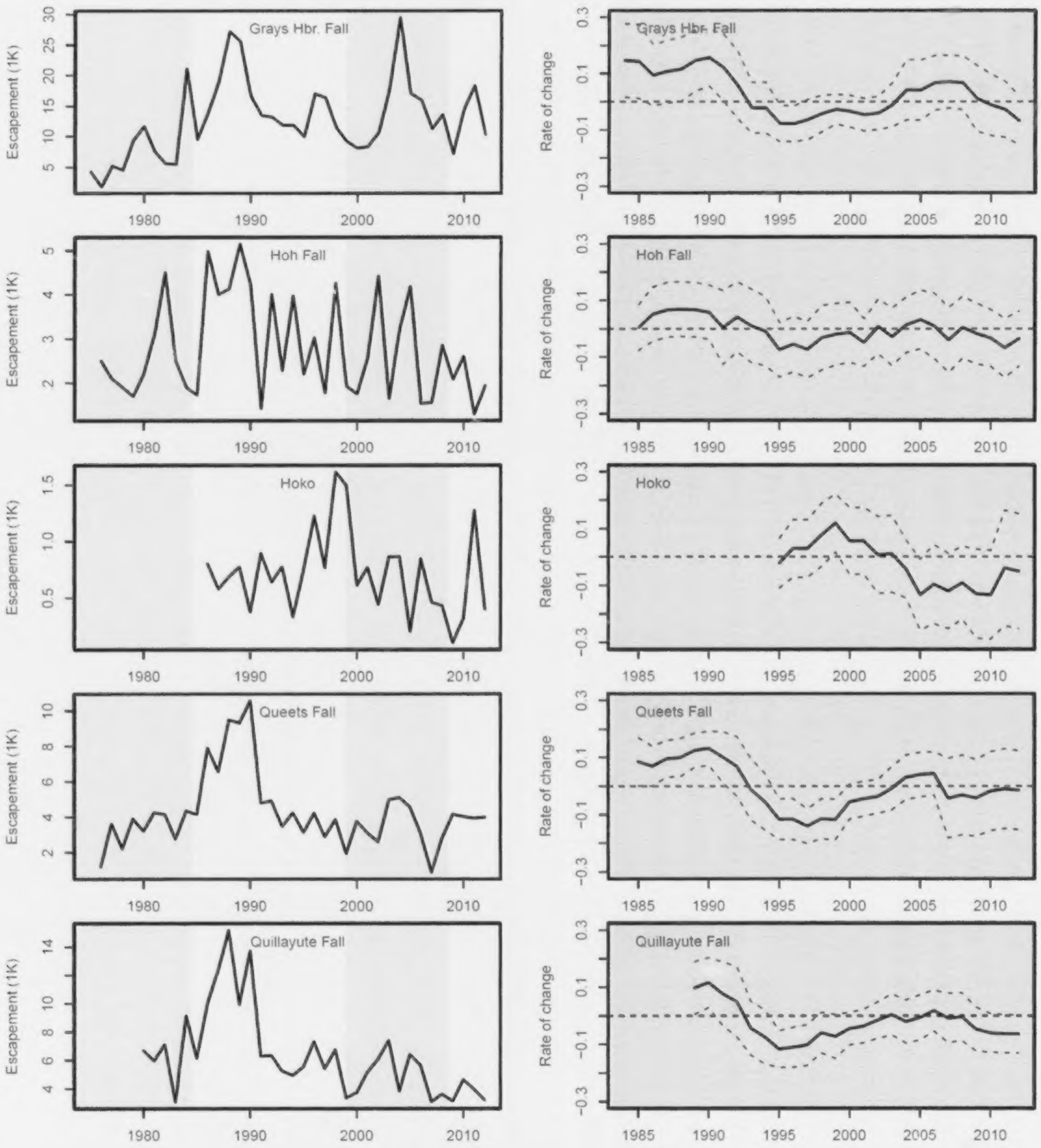

*Figure 3.3.3.2.6.–Escapement time series plots (left column) and retrospective evaluations of abundance trends for the historical record of escapements (right column) for Washington Coast Fall indicator stocks.*

*Note: In left column figures, the alternating gray shaded areas denote periods corresponding to pre-treaty (<1985) and post-treaty agreement periods (1985–1999, 1999–2008, 2009+). In the right column figures, the y-axis 'Rate of change' is the slope from a log$_e$(escapement) vs. year regression for the ten-year period ending in the year given on the x-axis. Solid lines denote point estimates for log$_e$(esc.) vs. time slope parameters, whereas dashed lines denote upper and lower confidence bounds (95%) on these values. Points lying below the zero horizontal reference line indicate years preceded by recent decline, whereas those above imply recent escapement increase.*

A simultaneous evaluation of spawning escapement and cumulative mature-run equivalent exploitation rates shows management of Queets River fall Chinook salmon (Figure 3.3.3.2.7) in the "safe zone" of spawning escapement exceeding the goal and exploitation rates below $S_{MSY}$ in all years except 1999 and 2007. Management for escapement and mature-run exploitation rate was in the safe zone in all years for Quillayute (Figure 3.3.3.2.8) and Hoh (Figure 3.3.3.2.9) rivers. Productivity of these stocks is high, evidenced by their high $U_{MSY}$ (0.87 for Queets and Quillayute; 0.90 for Hoh), which provides for less stringent management than some stocks necessitate. From this synoptic evaluation perspective, these coastal Washington stocks exhibit a track record demonstrative of sustainable management. Further, this view of the fishery impact and escapement data suggests that much of the variation in escapements for these stocks has been driven by non-fishing factors (e.g., anomalously high or low marine survival).

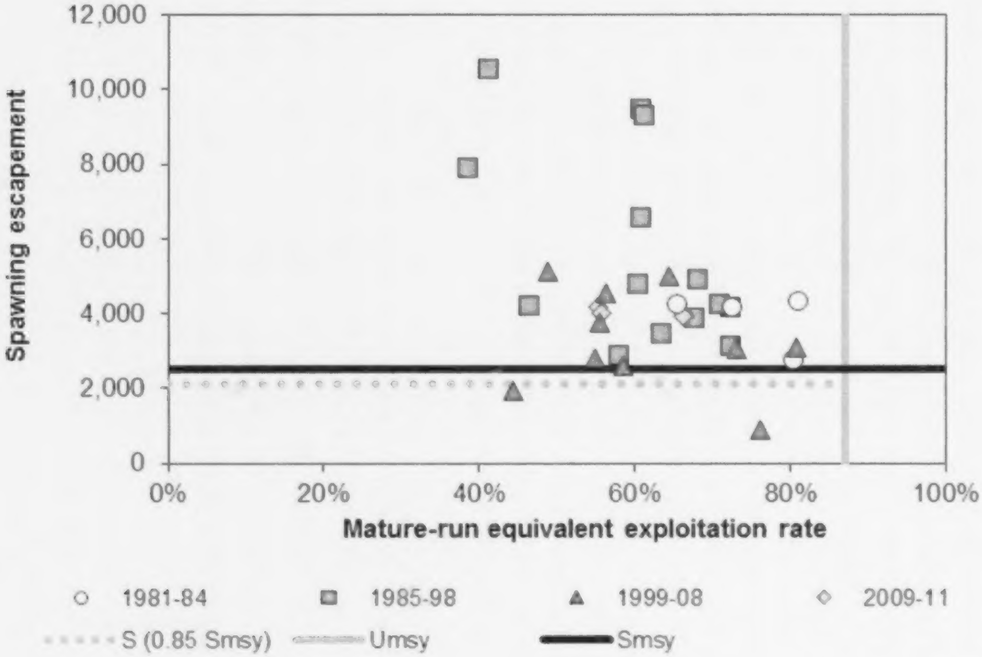

*Figure 3.3.3.2.7.–Queets River fall Chinook salmon spawning escapement and cumulative mature-run equivalent exploitation rate calculated from Queets River PSC indicator CWTs.*

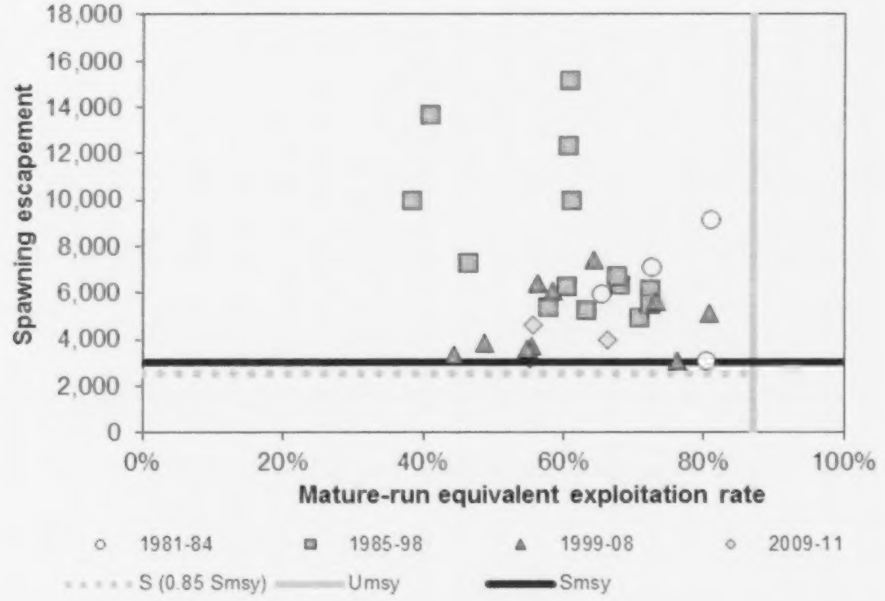

*Figure 3.3.3.2.8.–Quillayute River fall Chinook salmon spawning escapement and cumulative mature-run equivalent exploitation rate calculated from Queets River PSC indicator CWTs.*

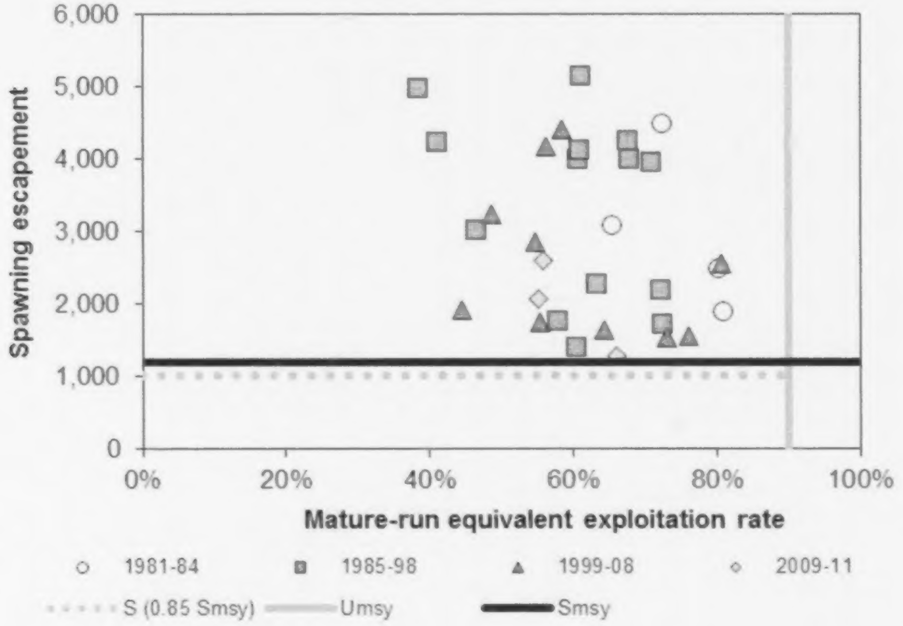

*Figure 3.3.3.2.9.–Hoh River fall Chinook salmon spawning escapement and cumulative mature-run equivalent exploitation rate calculated from Queets River PSC indicator CWTs.*

### 3.3.3.3 *Columbia River*

#### 3.3.3.3.1 Columbia River Summers

Mid-Columbia summer Chinook salmon are the only escapement indicator stock in this stock group. Since 2008, Columbia upriver summer Chinook salmon have been managed in-river by co-managers for a spawning escapement of 17,000, including 13,500 Wenatchee/Entiat/Chelan tributary spawners, and 3,500 Methow/Okanagan tributary spawners, and an additional 3,000 fish for hatchery brood stock. In-river fisheries are managed using a sliding scale of harvest rates based on the expected terminal run size.

For consistency with the CTC escapement goal, the synoptic evaluation shows combined hatchery and wild fish past Rock Island Dam (Figure 3.3.3.3.1.1). These counts of Chinook salmon past Rock Island Dam have exceeded 40,000 since 2009 while the stock has shown exploitation rates of 50% to 60%. Survival rates have been mostly below average since brood year 1997 but have been slowly improving (Figure 3.3.3.3.1.2).

*U.S. v. Oregon* co-managers account for substantial sport and Colville tribal fisheries that occur in mainstem spawning areas above Rock Island Dam (*U.S. Oregon* TAC 1999). The CTC goal of 12,143 summer Chinook salmon past Rock Island Dam was developed prior to the fisheries that now take place above Rock Island Dam and should be updated to better represent recent population dynamics.

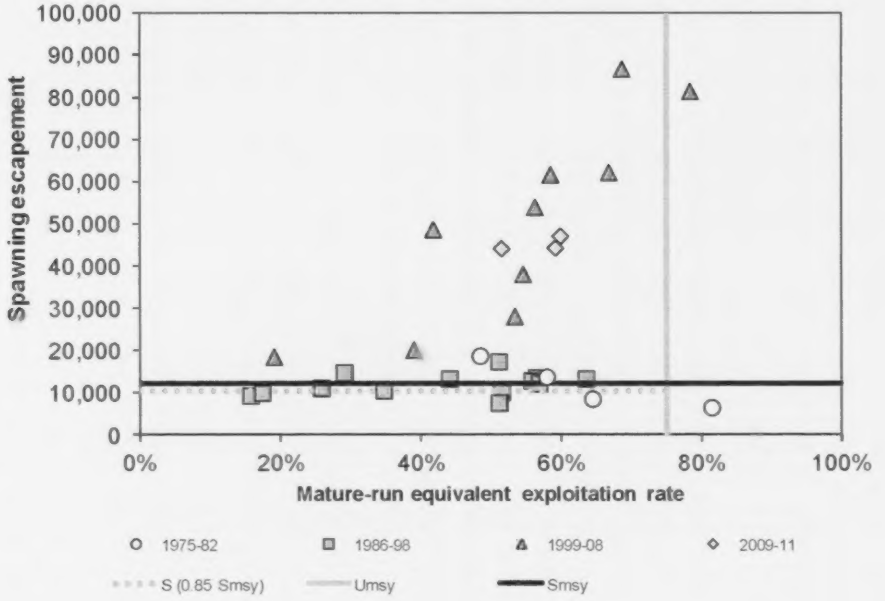

*Figure 3.3.3.3.1.1.–Mid-Columbia summer Chinook salmon spawning escapement past Rock Island Dam and cumulative mature-run equivalent exploitation rate calculated from Wells Hatchery PSC indicator CWTs.*

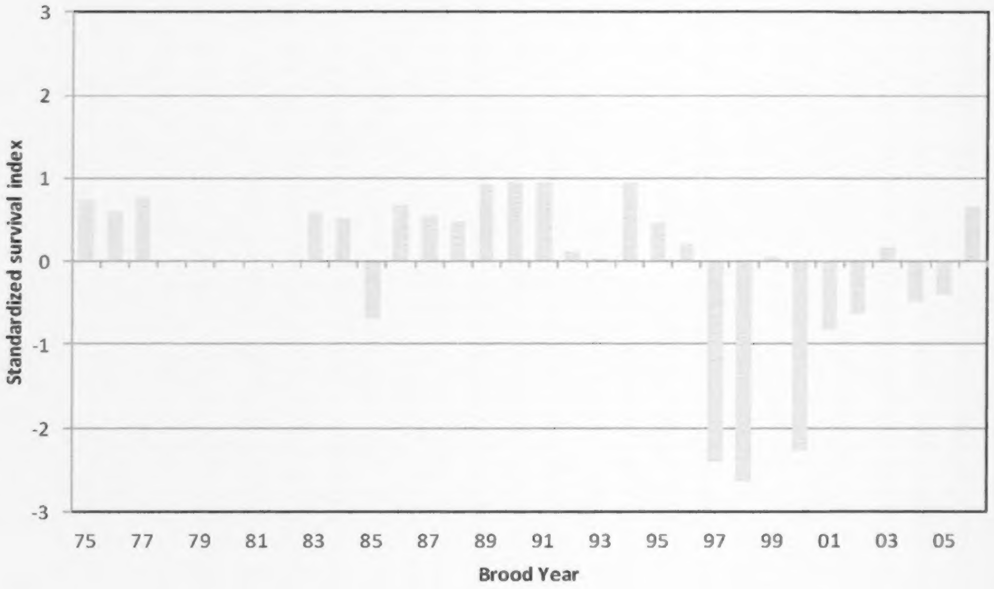

*Figure 3.3.3.3.1.2.–Marine survival index (standardized to a mean of zero) for Columbia Upriver Summer Chinook salmon.*

### 3.3.3.3.2 Columbia River Falls

The Columbia River Fall stock group in the annex tables has three escapement indicator stocks: Columbia Upriver bright, Deschutes River, and Lewis River wild. The Columbia Upriver bright management unit is comprised of all bright fall Chinook salmon returning above Bonneville Dam, including Deschutes, upper Columbia and Snake river populations. The CTC-agreed escapement goal for the upper Columbia fall Chinook salmon populations of 40,000 adult spawners past McNary Dam has been met since 1983, and the CTC goal of 4,532 Deschutes River fall Chinook salmon has been met since 1993, while exploitation rates have varied widely between 40% and 90% (Figure 3.3.3.3.2.1 and Figure 3.3.3.3.1.2).

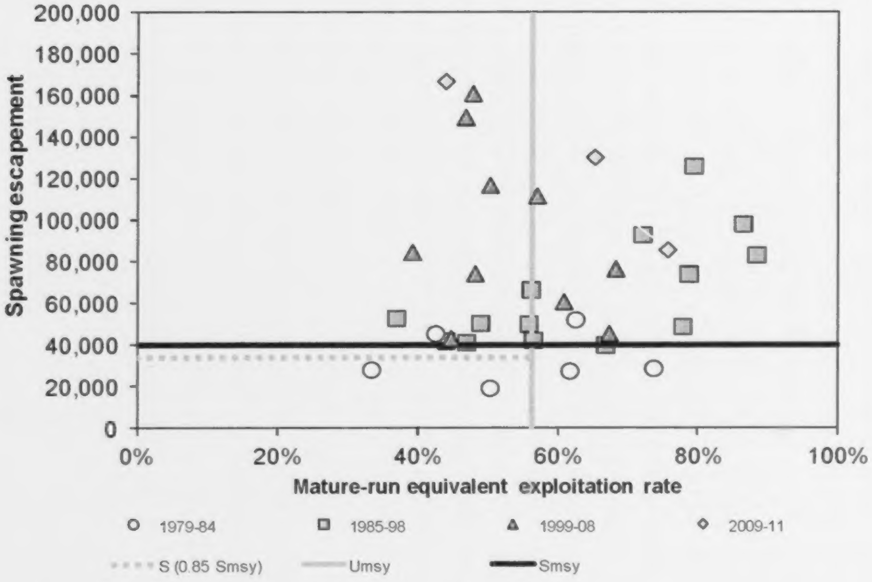

*Figure 3.3.3.3.2.1.–Upriver bright fall Chinook salmon spawning escapement and cumulative mature-run equivalent exploitation rate calculated from Priest Rapids Hatchery and Hanford Reach Wild PSC indicator CWTs.*

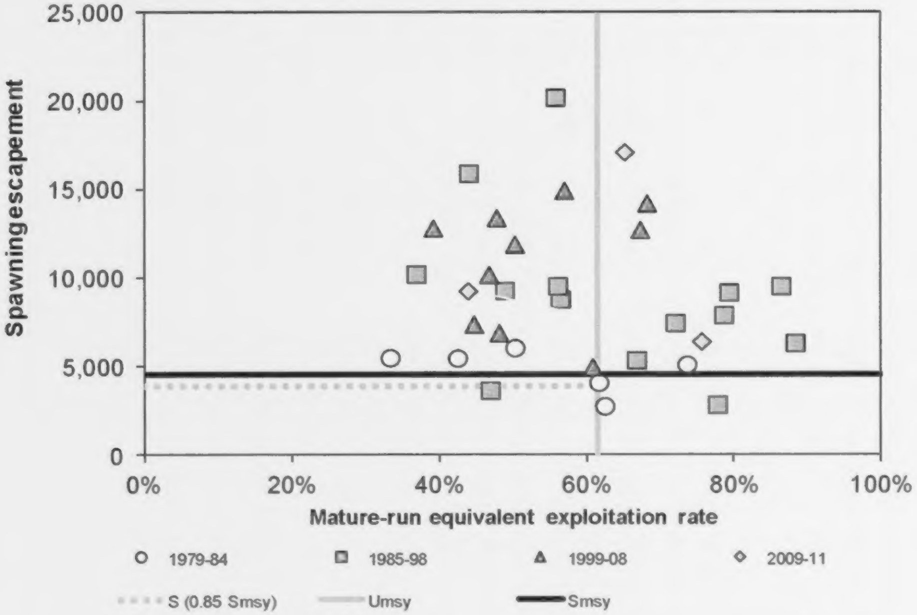

*Figure 3.3.3.3.2.2.–Deschutes River fall Chinook salmon spawning escapement and cumulative mature-run equivalent exploitation rate calculated from Priest Rapids Hatchery PSC indicator CWTs.*

The CTC escapement goal of 5,700 Lewis River fall Chinook salmon has been met since 2000, except for 2007 to 2009, when tributary returns were insufficient to meet escapement needs even in the absence of tributary fishing. Exploitation rates since 1980 have never exceeded the estimated $U_{MSY}$, but have varied widely from between 20% and 65% in recent years (Figure 3.3.3.3.2.3). Tributary fishing has been nonexistent or severely constrained since 2006, except for a catch of 3,016 in 2011, which contributed to a 65% exploitation rate.

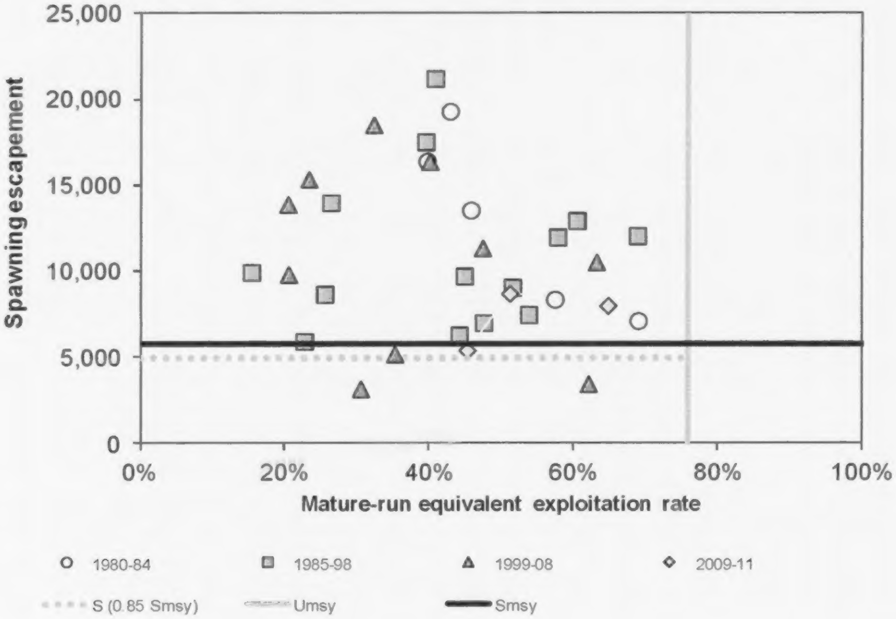

*Figure 3.3.3.3.2.3.–Lewis River Wild fall Chinook salmon spawning escapement and cumulative mature-run equivalent exploitation rate calculated from Lewis River Wild PSC indicator CWTs.*

Standardized survival indices for Columbia River Falls have been fairly stable. Only brood years 1998 and 1999 exceeded one standard deviation from average since the mid-80s (Figure 3.3.3.3.2.4 and Figure 3.3.3.3.2.6).

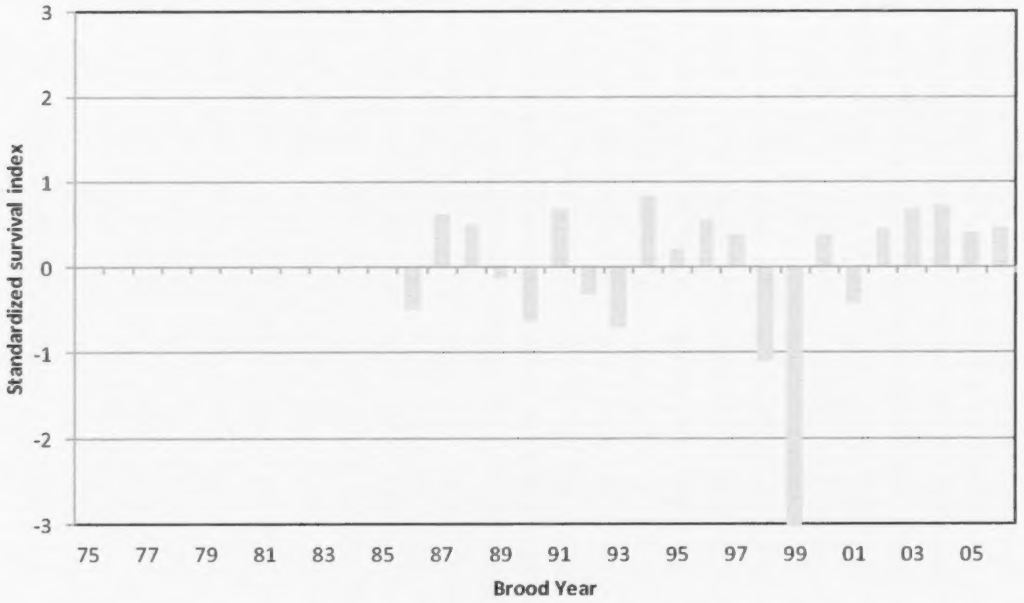

*Figure 3.3.3.3.2.4.–Marine survival index (standardized to a mean of zero) for Columbia Upriver bright Chinook salmon, as represented by Hanford Reach Wild Chinook salmon.*

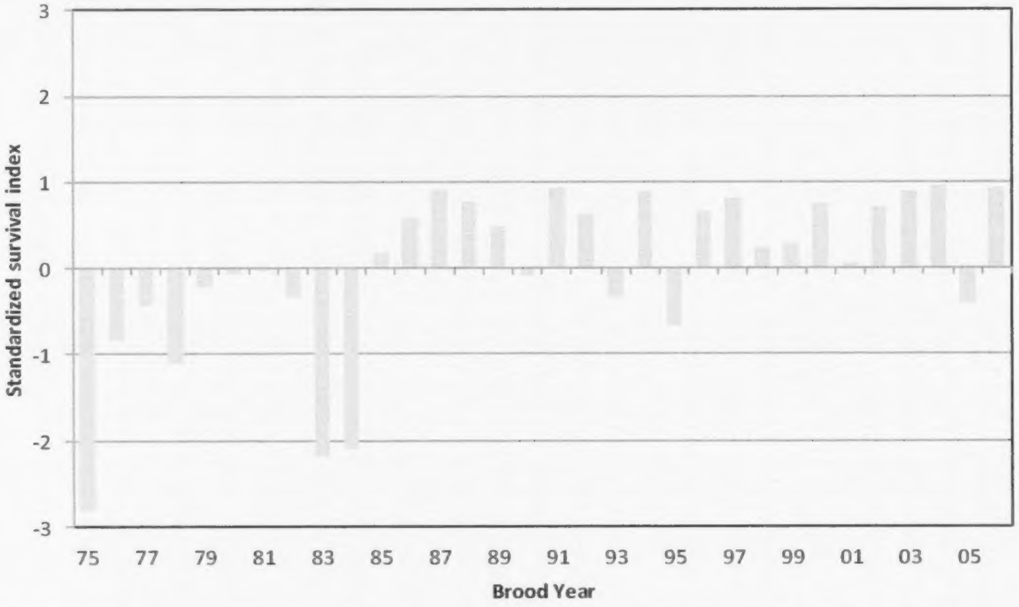

*Figure 3.3.3.3.2.5.–Marine survival index (standardized to a mean of zero) for Columbia Upriver bright Chinook salmon, as represented by Priest Rapids Hatchery Chinook salmon.*

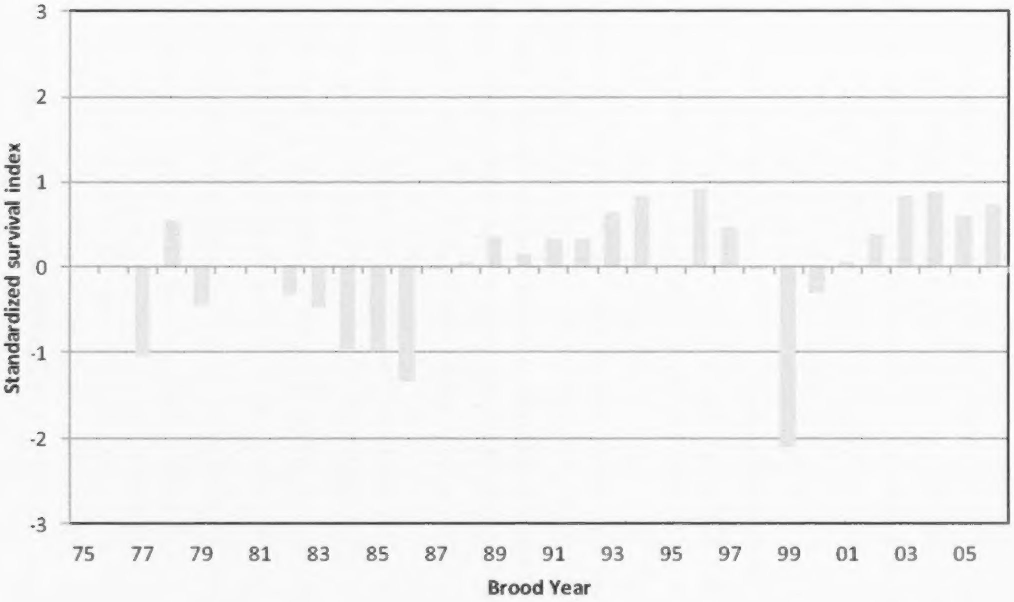

*Figure 3.3.3.3.2.6.–Marine survival index (standardized to a mean of zero) for Lewis River Wild fall Chinook salmon.*

## 3.3.3.4 *Coastal Oregon*

### 3.3.3.4.1 Oregon Coastal North Migrating

After a period of precipitous declines in escapement from 2007 to 2009, during the 2011 and 2012 return years the NOC stock aggregate has indicated signs of rebuilding to historical averages. Total estimated spawning escapement has ranged from approximately 39,000 in 2008 to 190,000 Chinook salmon in 1988. The 10-year (2002–2012) average for the NOC aggregate escapement is about 85,000 Chinook salmon. Estimated escapement in 2012 was 77,000 Chinook salmon. Abundance forecasts are expressed in terms of spawning escapement. Forecasted escapement for 2013 is 80,000 Chinook salmon.

All three NOC escapement indicator stocks failed to achieve goals in both 2007 and 2008, the Nehalem River did not attain its goal in either 2009 or 2010, but all three escapement indicator stocks exceeded the goals in 2012 and are forecasted to reach or exceed their goals in 2013. Recent year escapements in the southern range of the NOC (Siuslaw, Alsea) have shown encouraging rates of increase, while their northern counterparts (Nehalem, Tillamook, Nestucca) have displayed a more protracted rebuilding pattern. Escapements in the middle of the NOC area have been observed to be steadily rebuilding. Terminal fisheries management action, along with reductions in AABM fisheries, is contributing to the rebuilding of the NOC escapement. Terminal fisheries restrictions, which included closure in the Nehalem River during 2009, have been adopted and maintained through 2012. Many of these restrictions were dropped for the 2011 return year in the southern extent of the geographic aggregate, but most have been retained or extended through 2012 for basins north of the Nestucca. The analysis of stock synthesis status as represented by synoptic plots is confounded by different terminal exploitation experienced by the CWT group representing this stock group (Salmon River Hatchery) and the aggregate's three escapement indicator stocks (i.e., Nehalem, Siletz and Siuslaw basins). There is a directed high-intensity terminal fishery which impacts hatchery-origin fish returning to the Salmon River Hatchery. The terminal fishery impacts are lower magnitude on the NOC escapement indicator stocks. Nonetheless, analysis is ongoing to account for those differences to allow more comprehensive synoptic evaluations as summarized for other stocks in this report. Such analysis and material will be presented in future reports by the CTC. As shown in Figure 3.3.3.4.1, after a series of low marine survival from 2002 to 2006, which undoubtedly contributed towards failing escapements in the 2007 through 2008 return years, a higher marine survival in more recent years (2007–2009) may be similarly attributed with greater escapements in the 2011 and 2012 return years.

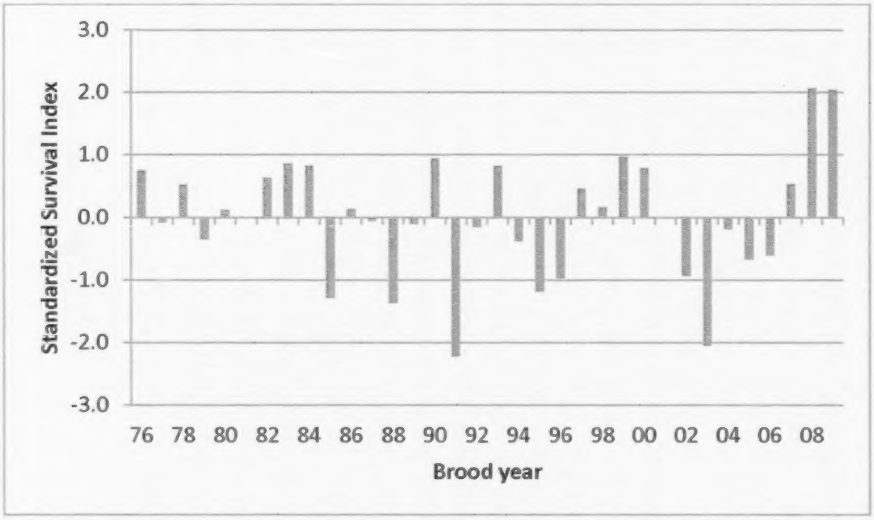

*Figure 3.3.3.4.1.*–Marine survival index (standardized to a mean of zero) for the Salmon River hatchery stock of Chinook salmon.

*Note: Brood years 1976–2009 are shown, with the exception of 1981, for which there is no information.*

### 3.3.3.4.2 Mid-Oregon Coast

After a period of precipitous declines in escapement from 2005 to 2007, the MOC stock aggregate has rebounded to historical averages during the 2010 through 2012 return years. Total aggregated estimated escapement for the MOC has ranged from a low of 7,556 in 2007 to a high of 53,860 in 2010. The 10-year average (2001–2012) escapement for the MOC is about 26,500 adult Chinook salmon. Estimated escapement in the MOC for 2012 was 27,623 adult Chinook salmon. Forecasted escapement for the 2013 return year is about 25,000 large bodied Chinook salmon. Marine survival, as indicated in Figure 3.3.3.4.2 has increased for those years from which recent recruitment has occurred and consequently expectation of average escapement is based on these observations.

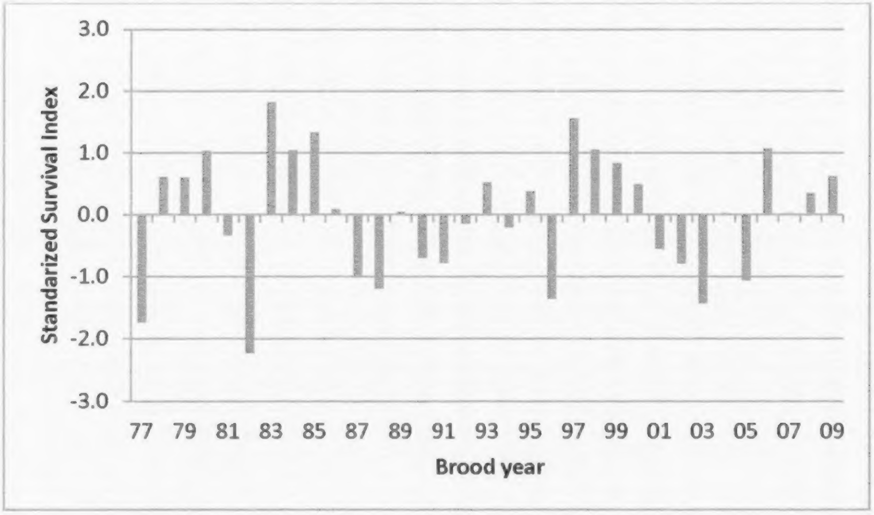

*Figure 3.3.3.4.2.–Marine survival index (standardized to a mean of zero) for the Elk River hatchery stock of Chinook salmon.*

*Note: Brood years 1977–2009 are shown.*

# 4 SENTINEL STOCKS PROGRAM

During recent negotiations within the PSC to amend the current Chinook salmon regime under Chapter 3, Annex IV of the PST, it became apparent that the accuracy and precision of spawning escapement estimates for many important natural stocks of Chinook salmon may not be adequate to support the Treaty management process. Reliable estimates of spawning escapements for a large number of natural Chinook salmon stocks over time are critical to assessing and monitoring the status of the resource throughout the Treaty area, as well as to determining whether adjustments to particular fisheries are necessary and effective for achieving the long-term conservation and production goals of the Treaty.

Recognizing the importance of better estimates of Chinook salmon spawning escapements, the Commission conceived the five-year SSP and included it as a specific requirement in the revised Chinook salmon regime (see Paragraph 3(a) of Chapter 3, Annex IV). The SSP is intended to focus on improving spawning escapement estimates for a select subset of important natural Chinook salmon stocks for which existing estimates are critical to fishery management decisions required by the Chinook salmon regime. Improving these estimates will bolster the scientific basis of the Chinook salmon regime, increase confidence in management decisions required under the new regime, and better inform the development of future regimes.

The goal of the SSP is to improve estimates of the spawning escapements for each of the included stocks to a level that meets or exceeds bilateral assessment accuracy and precision standards. Fourteen projects were funded by the SSP in 2012, the fourth year of the SSP. Summaries for each project are reported in Appendix C.

## 4.1 Oregon

### 4.1.1 Nehalem River

The 2012 spawning escapement, 12,952 (CV = 19%) was estimated using MR methods. Returning fish were captured using nets and weirs and then marked with opercular punches. Subsequent carcass surveys were undertaken to recover marked and unmarked fish from the spawning grounds. A creel survey was also conducted to both identify instances when marked fish were removed from the system and to generate timely and robust estimates of terminal harvest.

### 4.1.2 Siletz River

This MR program relied on nets and weirs to capture returning fish in the lower river, which were then marked with opercular punches. Carcasses were examined for marks at the spawning grounds. A creel survey was also conducted to estimate removals of marked fish by the terminal sport fishery, and estimate the terminal harvest. The preliminary 2012 spawning escapement was estimated at 8,738 Chinook salmon (CV = 19%).

## 4.2 Puget Sound

Three escapement studies were funded in Puget Sound, all employing genetic Lincoln-Petersen MR abundance estimates (GMR). Due to the requirement to sample downstream migrant juvenile fish to obtain a recapture sample, these programs all generated estimates of escapements in 2011, whereas all other SSP studies summarized in this section reported estimates for escapements in 2012.

### 4.2.1 Green River

The abundance of Chinook salmon spawning to the Green River in 2011 was estimated using GMR. Spawning adults were marked by obtaining a DNA microsatellite profile from tissue sampled from adult carcasses. Marks were later recaptured by sampling out-migrating smolts (captures) and genetically identifying some fraction of marks as parents of some out-migrating offspring. The preliminary estimate of Chinook salmon total spawner abundance for upstream of the smolt trap was 3,382 (CV = 5%).

### 4.2.2 Stillaguamish River

The abundance of Chinook salmon spawning in the Stillaguamish River in 2011 was estimated using GMR methods. Spawning adults were marked by obtaining a DNA microsatellite profile from tissue sampled from adult carcasses. Marks were later recaptured by sampling out-migrating smolts (captures) and genetically identifying some fraction of marks as parents of some out-migrating offspring. Unmarked hatchery juveniles and yearlings can present some challenges to the program, and the preliminary GMR results include corrections for unmarked hatchery juveniles and no adjustment for yearlings was necessary since none were observed. The preliminary estimate of Chinook salmon spawner abundance was 1,296 (CV = 6%).

### 4.2.3 Snohomish River

The abundance of Chinook salmon spawning in the Skykomish and Snoqualmie rivers in 2011 were estimated using GMR techniques. As with other Puget Sound rivers, spawning adults from both the Skykomish and Snoqualmie rivers were marked by obtaining a DNA microsatellite profile from tissue sampled from adult carcasses (first sampling event). Marks were later recaptured by sampling out-migrating sub-yearling smolt offspring (second sampling event) and genetically identifying some fraction of marks as parents of some out-migrating offspring. Preliminary unadjusted estimates of Chinook spawner abundance for areas upstream of each smolt trap were 6,857 Chinook salmon in the Skykomish River and 3,542 Chinook salmon in the Snohomish River. Performance standards were not met with GMR for 2011 (CV >15% for both estimates) due to low juvenile trap efficiencies and few carcass recoveries from the spawning ground surveys.

## 4.3 West Coast Vancouver Island

### 4.3.1 Burman River

The Burman River project estimated spawning escapement (4,119 Chinook salmon; CV = 10%) using MR methods. Returning fish were captured with beach seines in the lower river and then tagged and released. Carcasses were recovered upstream at the spawning grounds and examined for tags. Chinook salmon escapement (4,051) was also estimated using snorkel surveys and AUC methods. Visual observations of live radio marked fish were used to estimate observation efficiency (mean = 0.52; SE = 0.41) during 22 snorkel surveys. Survey life was estimated with radio tags (mean = 5.0; SE = 4.1; *n* = 108) and independently from visual tag depletion curves. Individual radio tags were intended to signal time of death by emitting an altered code when motion of the tagged fish had ceased for 12 hours, however many of the radio tags did not function as intended or operated in reverse with the inactive code preceding the active code signal. Fixed telemetry receiver sites were established at the lower and upper bounds of the spawning area. Only 1 (<1%) radiotagged Chinook salmon was detected leaving the Burman River two weeks after tagging; that fish was detected at the nearby Gold River.

### 4.3.2 Marble, Tahsis, and Leiner Rivers

This project was conducted to estimate survey life of Chinook salmon entering survey areas and to estimate observer efficiency of swimmers counting fish as a means to improve AUC estimates of spawner abundance. These empirical data were used to develop improved AUC estimates of Chinook salmon spawner abundance while normative procedures were used to generate AUC estimates as provided to the CTC. The estimated mean survey life of Chinook salmon was 25.4 days (SD = 15, *n* = 10) in the Tahsis River, 28.8 days (SD = 14, *n* = 38) in the Leiner River, and 27.4 days (SD = 14, *n* = 10) in the Marble River. Estimates of observer efficiency ranged from 33% to 100% in the Tahsis and Leiner rivers and from 13% to 100% in the Marble River. The AUC estimates using measured survey life and observer efficiency at Marble (2,509), Tahsis (227), and Leiner (772) rivers exceeded the normative AUC estimates provided to the CTC for Marble (2,364), Tahsis (566) and Leiner (163) rivers.

### 4.3.3 West Coast Vancouver Island Statistical Framework to Assess Chinook Salmon Escapement

A Canadian Science Advisory Process workshop has been scheduled for June 2013. The goal of the workshop is to produce Chinook salmon escapement monitoring framework for the WCVI area.

## 4.4 Fraser River

### 4.4.1 South Thompson River

Spawning escapement to the South Thompson age-.3 aggregate will be estimated using a combination of genetic, scale age, and CWT information collected from the Northern BC troll fishery and Albion (Fraser River) gillnet test fishery, along with CWT information collected at the Lower and Middle Shuswap rivers. A Bayesian estimation model will be used to estimate escapement while considering uncertainty in these information sources. For 2011, the estimate of Chinook salmon total spawner abundance for age-3 and older was 145,700 (CV = 17%). For 2012, genetic samples collected at Albion have recently been processed, and analyses to estimate the aggregate escapement are expected to commence in late May 2013. The 2012 escapement will be reported in next year's CTC catch and escapement report.

### 4.4.2 Chilko River

The 2012 escapement of Chinook salmon to the Chilko River (4,222, CV = 6%) was estimated using a two-event MR study, and concurrent aerial visual surveys. Petersen tags and sex-specific secondary marks were applied to returning salmon and recovery sampling was undertaken on carcasses.

### 4.4.3 Harrison River

Radio telemetry was used to determine whether this two-event MR study met the assumption of closure and to investigate the behaviour and distribution of the spawning population. Ninety-four radio tags were applied proportionally to male and female Chinook salmon throughout the MR tag application period. Movements of tagged fish were monitored throughout the entire MR study. All radiotagged Chinook salmon were tracked within the Harrison River, except for one radio tag that failed directly after application and release. All radiotagged Chinook salmon remained within the Harrison River MR study area to spawn. None passed above the upper boundary of the study area and none entered the nearby Chilliwack River. Fourteen radiotagged fish passed the lower boundary of the study area, and three of these were confirmed as carcasses downstream of the Harrison-Fraser confluence. It is likely that all 14 of these radiotagged fish were either moribund or recently dead, and very unlikely to have spawned elsewhere. Overall, the assumption of closure for the two-event MR was confirmed based on the results of this study. The adult spawning escapement was estimated at 44,500 fish (CV = 9%) based on the MR study.

## 4.5 Northern BC

### 4.5.1 Skeena River

The escapement of summer timed Chinook salmon to the Skeena River in 2012 was estimated at 36,006 fish (CV = 16%). Genetic analysis of representative samples collected at the Tyee test fishery and the spawning abundance in the Kitsumkalum River were used to generate the estimate. The SSP funded the genetic analysis of the test fishery samples in order to identify fish originating from the Kitsumkalum River. The Kitsumkalum River Chinook salmon escapement was estimated from an independent MR project. The Kitsumkalum escapement estimate was expanded to an estimate for the aggregate of Skeena River summer timed Chinook salmon using the proportion of Chinook salmon identified as Kitsumkalum in the Tyee Test fishery catch.

### 4.5.2 Skeena River Retrospective Analysis

In 2012, historical escapements to the Skeena River were investigated using similar techniques to those described above. DNA was extracted from archived Tyee test fishery scale samples and analyzed to determine stock composition, and the ratios of fish of Kitsumkalum River origin. Escapement estimates were generated for 13 previous years between 1984 and 2008. Estimated escapements to the Skeena ranged from 36,006 (CV = 16%) to 155,474 (CV = 7%). The escapement estimates and associated CVs are presented in Appendix Table C.9.

### 4.5.3 Nass River

This SSP project was part of a larger basin-wide escapement program where Chinook salmon were captured and tagged at fish wheels in the Lower Nass River and then recovered and examined for marks at upstream tributaries to generate a MR estimate. The SSP partly funded fish wheel operations and funded the operation of a counting fence on the Kwinageese River and carcass surveys on Damdochax Creek. The total run above the GW fish wheels was estimated to be 8,966 Chinook salmon (CV = 6%); 308 Chinook salmon were harvested above Grease Harbor and the spawning escapement above the GW fish wheels was estimated to be 8,688 Chinook salmon—the second lowest return recorded since the fish wheel program was initiated in 1994.

# REFERENCES CITED

ADF&G (Alaska Department of Fish and Game). 2013. Chinook salmon stock assessment and research plan, 2013. Alaska Department of Fish and Game, Special Publication No. 13-01, Anchorage.

ADF&G (Alaska Department of Fish and Game). 1981. Proposed management plan for Southeast Alaska Chinook salmon runs in 1981. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Report 1J81-03, Douglas.

Ames, J. and D. E. Phinney. 1977. 1977 Puget Sound summer-fall Chinook methodology: escapement estimates and goals, run size forecasts, and in-season run size updates. Washington Department of Fisheries Technical Report 29, Olympia, WA.

Argue, A.W., J. Coursley, and G. D.Harris. 1977. Preliminary revision of Georgia Strait and Juan de Fuca Strait tidal salmon sport catchsStatistics, 1972-1976, based on Georgia Strait head recovery program data. Technical Report Series PAC/T-77-16.

Bernard, D. R. and E. L. Jones III. 2010. Optimum escapement goals for Chinook salmon in the Transboundary Alsek River. Alaska Department of Fish and Game, Fishery Manuscript 10-02. Anchorage.

Bernard, D. R., S. A. McPherson, K. A. Pahlke, and P. Etherton. 2000. Optimal production of Chinook salmon from the Stikine River. Alaska Department of Fish and Game, Fishery Manuscript No. 00-01, Anchorage.

CCMP (Comprehensive Chinook Management Plan). 2010. Comprehensive Chinook management plan for Puget Sound Chinook: harvest management component. Northwest Indian Fisheries Commission and Washington Department of Fish and Wildlife, Olympia, WA.

CDFO (Canadian Department of Fisheries and Oceans). 2009. Revisions to official CDFO commercial Pacific Salmon catch estimates for 1996-2004. CDFO Canadian Science Advisory Secretariat. Science Advisory Report 2009/031.

Clark, J. H., S. A. McPherson and D. M. Gaudet. 1998. Biological escapement goal for Andrew Creek Chinook salmon. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 5J98-08, Juneau.

Cooney, T. D. 1984. A probing approach for determining spawning escapement goals for fall Chinook salmon on the Washington north coast. Pages 205-213 [*In*] J. M. Walton and D. B. Houston, editors. Proceedings of the Olympic Wild Fish Conference, Peninsula College, Port Angeles, WA.

CRFMP. 1988. Columbia River Fisheries Management Plan.

CTC (Chinook Technical Committee). 1997. Incidental fishery mortality of Chinook salmon: Mortality rates applicable to Pacific Salmon Commission Fisheries Report TCCHINOOK (97)-1, Vancouver, BC.

CTC (Chinook Technical Committee). 1999. Maximum sustained yield or biologically based escapement goals for selected Chinook salmon stocks used by the Pacific Salmon Commission's Chinook Technical Committee for escapement assessment. Pacific Salmon Commission, Report TCCHINOOK (99)-3, Vancouver, BC.

CTC (Chinook Technical Committee). 2002b. Catch and escapement of Chinook salmon under Pacific Salmon Commission jurisdiction 2001. Pacific Salmon Commission, Report TCCHINOOK (02)-1. Vancouver, BC.

## REFERENCES CITED (Continued)

CTC (Chinook Technical Committee). 2004a. Catch and escapement of Chinook salmon under Pacific Salmon Commission jurisdiction 2003. Pacific Salmon Commission, Report TCCHINOOK (04)-2. Vancouver, BC.

CTC (Chinook Technical Committee) 2004b. Standardized fishery regimes for Southeast Alaska Chinook fisheries. Pacific Salmon Commission, Report TCCHINOOK (04)-3. Vancouver, BC.

CTC (Chinook Technical Committee). 2004c. Estimation and application of incidental fishing mortality in Chinook salmon management under the 1999 Agreement of the Pacific Salmon Treaty. Pacific Salmon Commission, Report TTCHINOOK (04)-1, Vancouver, BC.

CTC (Chinook Technical Committee). 2005. Catch and escapement of Chinook salmon under Pacific Salmon Commission jurisdiction, 2003. Pacific Salmon Commission, Report TCCHINOOK (05)-2, Vancouver, BC.

CTC (Chinook Technical Committee). 2011. Development of the Technical Basis for a Chinook Salmon Total Mortality Management Regime for the PSC AABM Fisheries. *February* 2011. Pacific Salmon Commission, Report TCCHINOOK (11)-2. Vancouver, British Columbia.

CTC (Chinook Technical Committee). 2012. 2012 Exploitation Rate Analysis and Model Calibration. *December* 2012. Pacific Salmon Commission, Report TCCHINOOK (12)-4. Vancouver, British Columbia.

Davidson, W., R. Bachman, K. Clark, B. Meredith, E. Coonradt, D. Harris, and T. Thynes, 2011a. 2011 Southeast Alaska drift gillnet Fishery Management Plan. Alaska Department of Fish and Game, Regional Information Report 1J11-03, Douglas.

Davidson, W., T.Thynes, D. Gordon, A. Piston, K. Monagle, and S. Walker. 2011b. 2011 Southeast Alaska Purse Seine Fishery Management Plan. Alaska Department of Fish and Game, Regional Information Report 1J11-05, Douglas.

English, K. K., R. E. Bailey, and D. Robichaud. 2007. Assessment of Chinook salmon returns to the Fraser River using run reconstruction techniques, 1984-02. Canadian Science Advisory Secretariat, Research Document 2007/020.

Ericksen, R. P. and S. A. McPherson. 2003. Biological escapement goal for Chilkat River Chinook salmon. Alaska Department of Fish and Game, Fishery Manuscript 03-01, Juneau.

Farwell, M. K., R. E. Bailey, and B. Rosenberger. 1999. Enumeration of the 1995 Nicola River Chinook salmon escapement. Canadian Manuscript Report Fisheries and Aquatic Science 2491:44.

Fleischman, S.J., J. A. Der Hovanisian, and S. A. McPherson. 2011. Escapement goals for Chinook salmon in the Blossom and Keta rivers. Alaska Department of Fish and Game, Fishery Manuscript Series No. 11-05, Anchorage.

Fraser, F. J., P. J. Starr, A. Y. Fedorenko. 1982. A review of the Chinook and Coho Salmon of the Fraser River. Canadian Technical Report of Fisheries and Aquatic Sciences No. 1126.

Freeman, G. M., S. A. McPherson and D. L. Magnus. 2001. A mark-recapture experiment to estimate the escapement of Chinook salmon in the Keta River, 2000. Alaska Department of Fish and Game, Fishery Data Series 01-19, Anchorage.

Garcia, S. M. and De Leiva Moreno, J. I. 2005. Evolution of the state of fish stocks in the Northeast Atlantic within a precautionary framework, 1970-2003: a synoptic evaluation. *ICES Journal of Marine Science*, 62: 1603-1608.

## REFERENCES CITED (Continued)

Hendrich, C. F., J. L. Weller, S. A. McPherson, D. R. Bernard. 2008. Optimal production of Chinook salmon from the Unuk River. Alaska Department of Fish and Game, Fishery Manuscript No. 08–03, Anchorage.

Joint Columbia River Management Staff. 2013. 2012 Joint staff report, stock status and fisheries for spring Chinook, summer Chinook, sockeye, steelhead, and other species and miscellaneous regulations. Oregon Department of Fish and Wildlife, Clackamas Oregon. Washington Department of Fish and Wildlife, Vancouver, WA.

McIsaac, D. O. 1990. Factors affecting the abundance of 1977–79 brood wild fall Chinook salmon (*Oncorhynchus tshawytscha*) in the Lewis River, Washington. University of Washington, Seattle, WA.

McNicol, R.E. 1999. An assessment of Kitsumkalum River Chinook salmon, a North Coast indicator stock. Canadian Science Advisory Secretariat Research Document 99/164.

McPherson, S. A., D. R. Bernard, and J. H. Clark. 2000. Optimal production of Chinook salmon from the Taku River. Alaska Department of Fish and Game, Fishery Manuscript 00–2. Anchorage.

McPherson, S. A., E. L. Jones III, I. A. Boyce and S.J. Fleischman. 2010. Optimal production of Chinook salmon from the Taku River through the 2001 year class. Alaska Department of Fish and Game, Fishery Manuscript 10–03. Anchorage.

McPherson, S. A. and J. H. Clark. 2001. Biological escapement goal for King Salmon River Chinook salmon. Alaska Department of Fish and Game, Regional Information Report 1J01–40. Anchorage.

McPherson, S. A., P. Etherton, and J. H. Clark. 1998. Biological escapement goal for Klukshu River Chinook salmon. Alaska Department of Fish and Game, Fishery Manuscript No. 98–2, Anchorage.

McPherson, S. A. and J. Carlile. 1997. Spawner-recruit analysis of Behm Canal Chinook salmon stocks. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 1J97–06, Douglas.

PFMC (Pacific Fishery Management Council). 2008. Fishery Regulation Assessment Model (FRAM) An Overview for Coho and Chinook – v 3.0. Model evaluation workgroup. Pacific Fishery Management Council, 7700 NE Ambassador Place, St. 101, Portlad, OR 97220-1384. http://www.pcouncil.org/wp-content/uploads/FRAM_Overview_Final_1008.pdf (Accessed June 26, 2013).

Pacific Salmon Treaty Act of 1985. 1999 Agreement. U.S.-Canada. Public Law 99-5, 16 U.S.C. 3631.

PSC (Pacific Salmon Commission). 1991. A report to the Pacific Salmon Commission on a workshop held at Vancouver, B.C. January 10 and 11, 1991, to explore alternative Chinook management approaches. Pacific Salmon Commission, PSC file 72006, Vancouver, BC.

Pahlke, K. A. 1995. Coded wire tagging studies of Chinook salmon of the Unuk and Chickamin rivers, Alaska, 1983–1993. Alaska Fishery Research Bulletin 2(2):93–113.

Pahlke, K. A. 2003. Escapements of Chinook salmon in Southeast Alaska and transboundary rivers in 2001. Alaska Department of Fish and Game, Division of Sport Fish, Fishery Data Series 03–11, Anchorage.

Pahlke, K. A., and P. Etherton. 1999. Chinook salmon research on the Stikine River, 1997. Alaska Department of Fish and Game, Fishery Data Series No. 99–6, Anchorage.

# REFERENCES CITED (Continued)

Parken, C. K., R. E. Bailey, and J. R. Irvine. 2003. Incorporating Uncertainty into Area-under-the-Curve and Peak Count Salmon Escapement Estimation. North American Journal of Fisheries Management 23:78–90.

Parken, C. K., R. E. McNicol, and J. R. Irvine. 2006. Habitat-based methods to estimate escapement goals for data limited Chinook salmon stocks in British Columbia, 2004. Canadian Department of Fisheries and Oceans, Canadian Science Advisory Secretariat Research Document 2006/083.

PFMC (Pacific Fishery Management Council). 2003. Review of 2002 Ocean Salmon Fisheries. Pacific Fishery Management Council, Portland, OR.

QDNR (Quinault Department of Natural Resources). 1982. Assessment of stock and recruitment relationships for north coastal Chinook stocks. Quinault Department of Natural Resources, Technical Services Section, Taholah, WA.

Skannes, P. and G. Hagerman and L. Shaul, 2013. Annual management report for the 2012 Southeast Alaska/Yakutat salmon troll fisheries. Alaska Department of Fish and Game, Fishery Management Report No. 13-06, Anchorage.

Smith, C. J. and P. Castle. 1994. Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*) escapement estimates and methods – 1991. Washington Department of Fish and Wildlife, Project Report Series No. 1, Olympia, WA.

TAC (U.S. v Oregon Technical Advisory Committee). 1999. All Species Review: Columbia River Fish Management Plan.

Tompkins, A. B. Riddell, D. A. Nagtegaal, and D. Chen. 2005. A biologically-based escapement goal for Cowichan River fall Chinook salmon (*Oncorhynchus tshawytscha*). Canadian Science Advisory Secretariat Research Document 2005/095.

U.S. v. Oregon Parties. 2008. 2008–2017 U.S. v. Oregon Management Agreement. May 2008.

Vélez-Espino, L. A., McNicol, R. E, Brown, G., and Parken, C. K. 2010. Correction factors for numbers of released Chinook salmon reported in commercial troll logbooks: expanding the applications of the observer program. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2898.

Weller, J. L., D. J. Reed, and G. M. Freeman. 2007. Spawning abundance of Chinook salmon in the Chickamin River in 2005. Alaska Department of Fish and Game, Fishery Data Series No. 07–63, Anchorage.

Zhou, S., and R. Williams. 1999. Stock and recruitment analysis and escapement goals for Nehalem River fall Chinook. Oregon Department of Fish and Wildlife Information Reports 99-4, Fish Division, Portland.

Zhou, S., and R. Williams. 2000. Escapement goals for Siletz River and Siuslaw River fall Chinook based on stock and recruitment analysis. Oregon Department of Fish and Wildlife Information Reports 2000-04, Fish Division, Portland.

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Appendix A.1.–Southeast Alaska AABM Chinook salmon catches.

| | Southeast Alaska | | | | | | |
|---|---|---|---|---|---|---|---|
| Year | Troll | Net | Sport | Total | Add-on | Terminal Exclusion | Treaty Catch |
| 1975 | 287,342 | 13,365 | 17,000 | 317,707 | NA | NA | NA |
| 1976 | 231,239 | 10,523 | 17,000 | 258,762 | NA | NA | NA |
| 1977 | 271,735 | 13,443 | 17,000 | 302,178 | NA | NA | NA |
| 1978 | 375,919 | 25,492 | 17,000 | 418,411 | NA | NA | NA |
| 1979 | 337,672 | 28,388 | 16,581 | 382,641 | NA | NA | NA |
| 1980 | 303,643 | 20,114 | 20,213 | 343,970 | NA | NA | NA |
| 1981 | 248,782 | 18,952 | 21,300 | 289,034 | NA | NA | NA |
| 1982 | 241,938 | 46,992 | 25,756 | 314,686 | NA | NA | NA |
| 1983 | 269,821 | 19,516 | 22,321 | 311,658 | NA | NA | NA |
| 1984 | 235,622 | 32,405 | 22,050 | 290,077 | NA | NA | NA |
| 1985 | 215,811 | 33,870 | 24,858 | 274,539 | 6,246 | NA | 268,293 |
| 1986 | 237,703 | 22,099 | 22,551 | 282,353 | 11,091 | NA | 271,262 |
| 1987 | 242,562 | 15,532 | 24,324 | 282,418 | 17,095 | NA | 265,323 |
| 1988 | 231,364 | 21,788 | 26,160 | 279,312 | 22,525 | NA | 256,787 |
| 1989 | 235,716 | 24,245 | 31,071 | 291,032 | 21,510 | NA | 269,522 |
| 1990 | 287,939 | 27,712 | 51,218 | 366,869 | 45,873 | NA | 320,996 |
| 1991 | 264,106 | 34,864 | 60,492 | 359,462 | 61,476 | NA | 297,986 |
| 1992 | 183,759 | 32,140 | 42,892 | 258,791 | 36,811 | NA | 221,980 |
| 1993 | 226,866 | 27,991 | 49,246 | 304,103 | 32,910 | NA | 271,193 |
| 1994 | 186,331 | 35,654 | 42,365 | 264,350 | 29,185 | NA | 235,165 |
| 1995 | 138,117 | 47,955 | 49,667 | 235,739 | 58,800 | NA | 176,939 |
| 1996 | 141,452 | 37,298 | 57,509 | 236,259 | 72,599 | 8,663 | 154,997 |
| 1997 | 246,409 | 25,069 | 71,524 | 343,002 | 46,463 | 9,843 | 286,696 |
| 1998 | 192,066 | 23,514 | 55,013 | 270,593 | 25,021 | 2,420 | 243,152 |
| 1999 | 146,219 | 32,720 | 72,081 | 251,020 | 47,725 | 4,453 | 198,842 |
| 2000 | 158,717 | 41,400 | 63,173 | 263,290 | 74,316 | 2,481 | 186,493 |
| 2001 | 153,280 | 40,163 | 72,291 | 265,734 | 77,287 | 1,528 | 186,919 |
| 2002 | 325,308 | 31,689 | 69,537 | 426,534 | 68,164 | 1,237 | 357,133 |
| 2003 | 330,692 | 39,374 | 69,370 | 439,436 | 57,228 | 2,056 | 380,152 |
| 2004 | 354,658 | 64,038 | 80,572 | 499,268 | 75,955 | 6,295 | 417,019 |
| 2005[1] | 338,451 | 68,091 | 86,575 | 493,117 | 65,219 | 37,561 | 390,336 |
| 2006[1] | 282,315 | 67,396 | 85,794 | 435,505 | 48,511 | 25,711 | 361,283 |
| 2007[1] | 268,146 | 53,644 | 82,848 | 404,638 | 68,903 | 7,746 | 327,989 |
| 2008[1] | 151,936 | 43,029 | 49,265 | 244,230 | 66,183 | 6,064 | 171,983 |
| 2009[1] | 175,644 | 48,465 | 69,565 | 293,674 | 62,311 | 3,696 | 227,667 |
| 2010[1] | 195,495 | 30,582 | 58,503 | 284,580 | 54,289 | 937 | 229,355 |
| 2011[1] | 242,193 | 48,220 | 66,575 | 356,988 | 64,456 | 504 | 292,028 |
| 2012[2] | 209,392 | 39,483 | 46,520 | 295,395 | 53,205 | 1,175 | 241,015 |

*Note*: Troll, net, sport and total catches include catch of Southeast Alaska hatchery-origin fish and terminal exclusion catch; catches that count towards the all-gear ceiling (with hatchery add-on and terminal exclusion subtracted) are shown in the treaty catch column.

*Note*: NA = not applicable.

[1] Values changed because the method used to partition gillnet catch into large and non-large fish has changed. This change affects the computation of the terminal exclusion, add-on, and treaty catch.

[2] Preliminary value until sport mail-out survey results are available.

Appendix A.2.–Estimates of incidental mortality associated with Southeast Alaska AABM Chinook salmon treaty catches.

| Year | Troll | | Sport | | Net | | Total Treaty |
|---|---|---|---|---|---|---|---|
| | LIM | SIM | LIM | SIM | LIM | SIM | IM |
| 1985 | 15,319 | 79,828 | 2,397 | 3,413 | 6,545 | 41,606 | 149,107 |
| 1986 | 21,169 | 63,137 | 1,982 | 2,823 | 6,880 | 25,268 | 121,259 |
| 1987 | 35,097 | 66,688 | 2,112 | 3,007 | 1,142 | 10,730 | 118,776 |
| 1988 | 11,997 | 34,995 | 2,315 | 3,297 | 6,563 | 15,046 | 74,213 |
| 1989 | 24,573 | 47,841 | 2,788 | 3,970 | 7,305 | 32,912 | 119,390 |
| 1990 | 20,490 | 49,423 | 4,494 | 15,554 | 3,401 | 16,562 | 109,925 |
| 1991 | 22,633 | 41,165 | 2,831 | 5,292 | 3,605 | 18,803 | 94,330 |
| 1992 | 24,737 | 43,468 | 4,832 | 7,129 | 24,728 | 103,344 | 208,238 |
| 1993 | 20,148 | 44,953 | 4,277 | 5,979 | 2,580 | 12,194 | 90,131 |
| 1994 | 24,611 | 45,623 | 2,747 | 6,051 | 8,937 | 39,091 | 127,060 |
| 1995 | 13,745 | 29,666 | 3,020 | 5,291 | 3,440 | 12,441 | 67,602 |
| 1996 | 14,576 | 27,280 | 3,404 | 4,242 | 221 | 427 | 50,149 |
| 1997 | 11,452 | 25,423 | 6,768 | 6,219 | 729 | 3,049 | 53,640 |
| 1998 | 5,791 | 11,728 | 4,479 | 5,246 | 1,173 | 6,860 | 35,278 |
| 1999 | 16,517 | 15,618 | 5,924 | 8,835 | 514 | 2,357 | 49,764 |
| 2000 | 9,746 | 19,040 | 4,525 | 5,593 | 222 | 536 | 39,661 |
| 2001 | 11,020 | 24,406 | 5,633 | 5,993 | 426 | 1,621 | 49,100 |
| 2002 | 8,440 | 33,248 | 5,690 | 6,089 | 249 | 1,429 | 55,145 |
| 2003 | 10,678 | 20,196 | 5,147 | 6,804 | 415 | 9,232 | 52,471 |
| 2004 | 14,061 | 15,482 | 7,060 | 7,233 | 4,901 | 4,177 | 52,913 |
| 2005 | 11,910 | 13,947 | 5,854 | 9,420 | 176 | 4,709 | 46,016 |
| 2006 | 10,260 | 17,302 | 6,160 | 8,782 | 238 | 5,258 | 48,000 |
| 2007 | 10,631 | 21,672 | 5,249 | 8,841 | 4,003 | 20,323 | 70,719 |
| 2008 | 11,723 | 16,618 | 4,622 | 4,701 | 222 | 241 | 38,127 |
| 2009 | 11,623 | 18,358 | 4,820 | 6,439 | 138 | 3,515 | 44,893 |
| 2010 | 12,758 | 16,917 | 3,755 | 4,559 | 134 | 230 | 38,353 |
| 2011 | 10,405 | 14,839 | 6,190 | 7,285 | 383 | 2,598 | 41,700 |
| 2012[1] | 7,318 | 22,781 | 4,150 | 4,884 | 1,292 | 5,184 | 45,608 |

[1] Preliminary estimates for Sport IM and Total IM. Legal dropoffs in sport retention fishery estimated from creel estimate while all other IM for the Southeast Alaska sport fishery is estimated from the preliminary LC and the previous year IM to LC ratios. Final estimates are available from mail-out surveys in October one year post fishing season and will be reported in this appendix in the next annual catch and escapement Report.

Appendix A.3.–Estimates of incidental mortality associated with Southeast Alaska Chinook salmon total catches.

| Year | Troll | | Sport | | Net | | Total IM[1] |
|---|---|---|---|---|---|---|---|
| | LIM | SIM | LIM | SIM | LIM | SIM | |
| 1985 | 15,584 | 81,237 | 2,587 | 3,684 | 6,575 | 41,746 | 151,412 |
| 1986 | 21,690 | 64,744 | 2,346 | 3,342 | 7,224 | 26,491 | 125,837 |
| 1987 | 36,565 | 69,648 | 2,531 | 3,604 | 1,200 | 11,058 | 124,607 |
| 1988 | 12,502 | 36,744 | 2,722 | 3,876 | 6,813 | 15,442 | 78,100 |
| 1989 | 25,226 | 49,392 | 3,233 | 4,604 | 8,785 | 39,395 | 130,636 |
| 1990 | 21,761 | 53,067 | 5,565 | 19,262 | 4,499 | 21,260 | 125,414 |
| 1991 | 23,659 | 43,731 | 3,794 | 7,092 | 4,548 | 22,738 | 105,561 |
| 1992 | 25,574 | 45,574 | 5,863 | 8,651 | 26,524 | 110,309 | 222,497 |
| 1993 | 20,758 | 46,882 | 4,935 | 6,899 | 3,353 | 15,090 | 97,917 |
| 1994 | 25,489 | 47,395 | 3,281 | 7,228 | 10,987 | 47,326 | 141,706 |
| 1995 | 15,106 | 33,534 | 4,225 | 7,403 | 7,970 | 29,946 | 98,184 |
| 1996 | 15,502 | 30,411 | 5,022 | 6,259 | 1,349 | 4,968 | 63,512 |
| 1997 | 11,829 | 26,906 | 9,082 | 8,345 | 1,737 | 7,536 | 65,434 |
| 1998 | 5,939 | 12,211 | 5,322 | 6,233 | 2,013 | 11,680 | 43,398 |
| 1999 | 17,101 | 16,419 | 8,033 | 11,980 | 1,419 | 7,068 | 62,021 |
| 2000 | 10,483 | 21,726 | 6,898 | 8,526 | 828 | 2,675 | 51,136 |
| 2001 | 11,668 | 27,697 | 9,105 | 9,686 | 1,383 | 6,027 | 65,566 |
| 2002 | 8,787 | 35,345 | 8,695 | 9,305 | 573 | 4,116 | 66,822 |
| 2003 | 11,085 | 21,501 | 7,252 | 9,585 | 711 | 12,642 | 62,776 |
| 2004 | 14,742 | 16,618 | 10,266 | 10,516 | 6,959 | 5,776 | 64,878 |
| 2005 | 12,572 | 15,151 | 7,919 | 12,742 | 964 | 7,148 | 56,498 |
| 2006 | 10,619 | 18,178 | 7,552 | 10,766 | 849 | 8,636 | 56,600 |
| 2007 | 11,136 | 23,598 | 6,975 | 11,749 | 6,828 | 33,435 | 93,720 |
| 2008 | 12,336 | 18,551 | 6,963 | 7,081 | 734 | 1,102 | 46,768 |
| 2009 | 12,141 | 19,722 | 6,964 | 9,302 | 389 | 7,498 | 56,016 |
| 2010 | 13,236 | 17,992 | 4,956 | 6,018 | 501 | 1,243 | 43,945 |
| 2011 | 10,783 | 15,769 | 7,580 | 8,921 | 1,104 | 7,325 | 51,482 |
| 2012[2] | 7,634 | 24,582 | 5,297 | 6,233 | 4,432 | 18,192 | 66,370 |

[1] Includes total treaty, terminal exclusion, and hatchery add-on estimates of incidental mortality.

[2] Preliminary estimates for Sport IM and Total IM. Legal dropoffs in sport retention fishery estimated from creel estimate while all other IM for the Southeast Alaska sport fishery is estimated from the preliminary LC and the previous year IM to LC ratios. Final estimates are available from mail out surveys in October one year post fishing season and will be reported in this appendix in the next annual catch and escapement Report.

Appendix A.4.–Canadian Transboundary Rivers (Taku, Stikine, Alsek) ISBM Chinook salmon landed catch (LC), releases (Rel.), and incidental mortality (IM).

| Year | Transboundary Rivers | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | First Nations | | | Net | | | Sport | | | Total | | |
| | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM |
| 1975 | 1,024 | | | 178 | | | 0 | | | 1,202 | | |
| 1976 | 1,074 | | | 236 | | | 200 | | | 1,510 | | |
| 1977 | 450 | | | 62 | | | 300 | | | 812 | | |
| 1978 | 750 | | | 100 | | | 300 | | | 1,150 | | |
| 1979 | 2,150 | | | 872 | | | 734 | | | 3,756 | | |
| 1980 | 822 | | | 1,869 | | | 354 | | | 3,045 | | |
| 1981 | 736 | | | 977 | | | 556 | | | 2,269 | | |
| 1982 | 1,018 | | | 1,823 | | | 429 | | | 3,270 | | |
| 1983 | 1,375 | | | 1,553 | | | 355 | | | 3,283 | | |
| 1984 | 802 | | | 515 | | | 569 | | | 1,886 | | |
| 1985 | 1,066 | | | 759 | | | 654 | | | 2,479 | | |
| 1986 | 1,707 | | | 1,668 | | | 570 | | | 3,945 | | |
| 1987 | 1,491 | | | 1,512 | | | 823 | | | 3,826 | | |
| 1988 | 1,445 | | | 2,170 | | | 780 | | | 4,395 | | |
| 1989 | 1,433 | | | 2,799 | | | 722 | | | 4,954 | | |
| 1990 | 1,094 | | | 3,703 | | | 1,001 | | | 5,798 | | |
| 1991 | 1,572 | | | 2,717 | | | 834 | | | 5,123 | | |
| 1992 | 1,311 | | | 2,629 | | | 608 | | | 4,548 | | |
| 1993 | 1,248 | | | 2,830 | | | 909 | | | 4,987 | | |
| 1994 | 1,297 | | | 3,551 | | | 744 | | | 5,592 | | |
| 1995 | 1,464 | | | 3,567 | | | 1,465 | | | 6,496 | | |
| 1996 | 1,389 | | | 5,489 | | | 1,134 | | | 8,012 | | |
| 1997 | 1,584 | | | 6,336 | | | 811 | | | 8,731 | | |
| 1998 | 864 | | | 3,288 | | | 662 | | | 4,814 | | |
| 1999 | 1,516 | | | 4,117 | | | 662 | | | 6,295 | | |
| 2000 | 1,616 | | | 3,882 | | | 633 | | | 6,131 | | |
| 2001 | 954 | | | 2,461 | | | 659 | | | 4,074 | | |
| 2002 | 1,450 | | | 2,499 | | | 963 | | | 4,912 | | |
| 2003 | 1,659 | | | 3,839 | | | 651 | | | 6,149 | | |
| 2004 | 2,454 | | | 6,969 | | | 455 | | | 9,878 | | |
| 2005 | 1,119 | 0 | 51 | 9,515 | 0 | 438 | 35 | 0 | 2 | 10,669 | 0 | 492 |
| 2006 | 960 | 0 | 44 | 23,480 | 0 | 1,080 | 243 | 0 | 17 | 24,683 | 0 | 1,141 |
| 2007 | 781 | 0 | 36 | 14,715 | 0 | 0 | 145 | 0 | 10 | 15,641 | 0 | 46 |
| 2008 | 920 | 0 | 42 | 10,831 | 0 | 498 | 327 | 0 | 23 | 12,078 | 0 | 563 |
| 2009 | 773 | 0 | 36 | 8,378 | 510 | 868 | 140 | 0 | 10 | 9,291 | 510 | 913 |
| 2010 | 835 | 0 | 38 | 7,815 | 124 | 477 | 247 | 0 | 17 | 8,897 | 124 | 532 |
| 2011 | 784 | 0 | 36 | 5,028 | 158 | 444 | 253 | 275 | 70 | 6,065 | 433 | 550 |
| 2012 | 580 | 0 | 27 | 7,407 | 63 | 434 | 254 | 367 | 88 | 8,241 | 430 | 549 |

Appendix A.5.–Northern British Columbia (NBC) AABM Chinook salmon catches.

| | Northern British Columbia | | | |
|---|---|---|---|---|
| **Year** | **Area 1-5 Troll**[1,2] | **Area 1-5 CNR Troll**[1,3] | **Areas 1,2E, 2W Sport** | **Total** |
| 1975 | 228,121 | | 0 | 228,121 |
| 1976 | 190,267 | | 0 | 190,267 |
| 1977 | 130,899 | | 106 | 131,005 |
| 1978 | 146,054 | | 125 | 146,179 |
| 1979 | 147,576 | | 0 | 147,576 |
| 1980 | 157,198 | | 200 | 157,398 |
| 1981 | 153,065 | | 184 | 153,249 |
| 1982 | 173,472 | | 215 | 173,687 |
| 1983 | 162,837 | | 90 | 162,927 |
| 1984 | 185,134 | | 171 | 185,305 |
| 1985 | 165,845 | | 600 | 166,445 |
| 1986 | 175,715 | | 1,153 | 176,868 |
| 1987 | 177,457 | | 2,644 | 180,101 |
| 1988 | 152,369 | | 7,059 | 159,428 |
| 1989 | 207,679 | | 20,652 | 228,331 |
| 1990 | 154,109 | | 16,827 | 170,936 |
| 1991 | 194,018 | | 15,047 | 209,065 |
| 1992 | 142,340 | | 21,358 | 163,698 |
| 1993 | 161,686 | | 25,297 | 186,983 |
| 1994 | 164,581 | | 28,973 | 193,554 |
| 1995 | 56,857 | | 22,531 | 79,388 |
| 1996 | 8 | | 670 | 678 |
| 1997 | 83,261 | | 27,738 | 110,999 |
| 1998 | 109,072 | | 34,130 | 143,202 |
| 1999 | 54,097 | | 30,227 | 84,324 |
| 2000 | 9,948 | | 22,100 | 32,048 |
| 2001 | 12,934 | | 30,400 | 43,334 |
| 2002 | 102,731 | 130 | 47,100 | 149,961 |
| 2003 | 140,497 | 555 | 54,300 | 195,352 |
| 2004 | 167,508 | 2,298 | 74,000 | 243,806 |
| 2005 | 174,806 | 975 | 68,800 | 244,581 |
| 2006 | 151,485 | 8 | 64,500 | 215,993 |
| 2007 | 83,235 | 104 | 61,000 | 144,339 |
| 2008 | 52,147 | 0 | 43,500 | 95,647 |
| 2009 | 75,470 | 170 | 34,000 | 109,640 |
| 2010 | 90,213 | 1 | 46,400 | 136,614 |
| 2011 | 74,660 | 0 | 48,000 | 122,660 |
| 2012 | 80,257 | 0 | 40,050 | 120,307 |

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[1] Since 1998, the catch accounting year for troll fisheries was set from October 1 to September 30. To make comparisons to previous years more meaningful, the same catch accounting period was applied for years prior to 1998.

[2] Troll catches from 1996 to 2004 have been updated with data from CDFO (2009).

[3] Note that troll (Areas 1–5) and tidal sport (Areas 1, 2E, 2W) are the components of the Northern British Columbia aggregate abundance-based management fishery.

Appendix A.6.–Estimates of incidental mortality associated with Northern British Columbia (NBC) AABM Chinook salmon catches.

| Year | Area 1-5 Troll[1] | | Areas 1, 2E, 2W Sport | | Total |
|---|---|---|---|---|---|
| | LIM | SIM | LIM | SIM | IM |
| 1985 | 2,819 | 12,405 | 97 | 0 | 15,321 |
| 1986 | 2,987 | 19,637 | 204 | 0 | 22,828 |
| 1987 | 4,307 | 40,626 | 535 | 0 | 45,468 |
| 1988 | 4,829 | 40,749 | 1,505 | 0 | 47,083 |
| 1989 | 3,740 | 35,135 | 4,068 | 0 | 42,943 |
| 1990 | 5,195 | 46,172 | 3,248 | 0 | 54,615 |
| 1991 | 4,385 | 43,848 | 2,733 | 0 | 50,966 |
| 1992 | 4,985 | 49,332 | 3,634 | 0 | 57,951 |
| 1993 | 4,444 | 36,696 | 4,353 | 0 | 45,493 |
| 1994 | 3,709 | 27,882 | 4,524 | 0 | 36,116 |
| 1995 | 3,721 | 26,123 | 2,935 | 0 | 32,778 |
| 1996[2] | | | | | |
| 1997[2] | | | | | |
| 1998[2] | | | | | |
| 1999 | 920 | 674 | 3,604 | 0 | 5,198 |
| 2000 | 169 | 147 | 4,703 | 0 | 5,019 |
| 2001 | 376 | 276 | 5,947 | 0 | 6,599 |
| 2002 | 2,807 | 880 | 8,410 | 0 | 12,097 |
| 2003 | 4,751 | 696 | 9,515 | 0 | 14,962 |
| 2004 | 7,836 | 2,420 | 21,226 | 0 | 31,482 |
| 2005 | 4,934 | 4,593 | 12,174 | 0 | 21,701 |
| 2006 | 3,244 | 2,630 | 7,486 | 0 | 13,360 |
| 2007 | 2,094 | 3,063 | 7,845 | 0 | 13,003 |
| 2008 | 1,189 | 1,316 | 3,259 | 0 | 5,764 |
| 2009 | 1,874 | 3,075 | 3,964 | 0 | 8,913 |
| 2010 | 1,953 | 2,326 | 6,777 | 0 | 11,056 |
| 2011 | 7,732 | 1,773 | 9,114 | 0 | 18,619 |
| 2012 | 2,152 | 4,345 | 4,977 | 0 | 11,475 |

*Note*: Troll (Areas 1–5) and tidal sport (Areas 1, 2E, 2W) are the components of the Northern British Columbia aggregate abundance based management fishery.

[1] Since 1998, the catch accounting year for troll fisheries was set from October 1 to September 30. To make comparisons to previous years more meaningful, the same catch accounting period was applied for years prior to 1998.

[2] Release data are not yet available for 1996 to 1998.

Appendix A.7.–Northern British Columbia (NBC) ISBM Chinook salmon landed catch (LC), releases (Rel.), and incidental mortality (IM).

| | Area 1–5 First Nations | | | Area 1–5 Net | | | Tyee Test Fishery | | | Area 3–5 Sport | | | Area 1–5 Freshwater Sport | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM |
| 1975 | 4,055 | | | 25,095 | | | | | | 0 | | | 0 | | | 29,150 | | |
| 1976 | 2,791 | | | 16,105 | | | | | | 0 | | | 0 | | | 18,896 | | |
| 1977 | 6,998 | | | 44,196 | | | | | | 1,670 | | | 2,158 | | | 55,022 | | |
| 1978 | 5,363 | | | 27,924 | | | | | | 1,668 | | | 6,610 | | | 41,565 | | |
| 1979 | 5,266 | | | 40,640 | | | | | | 2,523 | | | 1,960 | | | 50,389 | | |
| 1980 | 10,121 | | | 26,895 | | | | | | 3,867 | | | 4,515 | | | 45,398 | | |
| 1981 | 11,115 | | | 41,724 | | | | | | 2,760 | | | 2,613 | | | 58,212 | | |
| 1982 | 13,255 | | | 44,844 | | | | | | 3,760 | | | 2,726 | | | 64,585 | | |
| 1983 | 15,532 | | | 17,134 | | | | | | 4,092 | | | 5,374 | | | 42,132 | | |
| 1984 | 11,408 | | | 31,321 | | | | | | 2,300 | | | 3,426 | | | 48,455 | | |
| 1985 | 15,794 | | | 39,562 | | | | | | 3,600 | | | 3,186 | | | 62,142 | | |
| 1986 | 24,448 | | | 23,902 | | | | | | 3,950 | | | 4,410 | | | 56,710 | | |
| 1987 | 16,329 | | | 18,357 | | | | | | 4,150 | | | 3,625 | | | 42,461 | | |
| 1988 | 21,727 | | | 31,339 | | | | | | 4,300 | | | 3,745 | | | 61,111 | | |
| 1989 | 21,023 | | | 38,623 | | | | | | 4,150 | | | 5,247 | | | 69,043 | | |
| 1990 | 27,105 | | | 28,359 | | | | | | 4,300 | | | 4,090 | | | 63,854 | | |
| 1991 | 23,441 | | | 40,899 | | | | | | 4,256 | | | 4,764 | | | 73,360 | | |
| 1992 | 27,012 | | | 35,716 | | | | | | 6,250 | | | 6,182 | | | 75,160 | | |
| 1993 | 21,353 | | | 33,944 | | | | | | 3,279 | | | 7,813 | | | 66,389 | | |
| 1994 | 15,949 | | | 22,032 | | | | | | 3,171 | | | 3,093 | | | 44,245 | | |
| 1995 | 13,635 | | | 18,076 | | | | | | 2,475 | | | 3,503 | | | 37,689 | | |

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Appendix A.7.–Page 2 of 2.

| Year | Area 1–5 First Nations | | | Area 1–5 Net | | | Tyee Test Fishery | | | Area 3–5 Sport | | | Area 1–5 Freshwater Sport | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM |
| 1996 | 13,345 | | | 33,080 | | | | | | 3,382 | | | 1,250 | | | 51,057 | | |
| 1997 | 14,610 | | | 22,355 | | | | | | 0 | | | 0 | | | 36,965 | | |
| 1998 | 20,622 | | | 7,833 | | | | | | 4,750 | | | 0 | | | 33,205 | | |
| 1999 | 27,399 | | | 11,387 | | | | | | 11,700 | | | 0 | | | 50,486 | | |
| 2000 | 23,476 | | | 22,849 | | | | | | 8,600 | | | 0 | | | 54,925 | | |
| 2001 | 23,508 | | | 25,410 | | | | | | 11,000 | | | 0 | | | 59,918 | | |
| 2002 | 14,125 | | | 15,211 | | | | | | 8,000 | | | 0 | | | 37,336 | | |
| 2003 | 20,950 | | | 15,230 | | | | | | 8,000 | | | 5,711 | | | 49,891 | | |
| 2004 | 20,548 | | | 12,305 | | | | | | 8,000 | | | 0 | | | 40,853 | | |
| 2005 | 17,553 | NA | 807 | 6,850 | 5,502 | 4,434 | 1,332 | NA | 61 | 8,000 | 0 | 0 | 0 | | | 33,735 | 5,502 | 5,302 |
| 2006 | 17,262 | NA | 794 | 12,561 | 9,904 | 8,059 | 1,178 | NA | 54 | 8,000 | 0 | 0 | 0 | | | 39,001 | 9,904 | 8,908 |
| 2007 | 14,087 | NA | 648 | 10,079 | 10,273 | 8,037 | 1,302 | NA | 60 | 8,000 | 0 | 288 | 0 | | | 33,468 | 10,273 | 9,033 |
| 2008 | 14,963 | NA | 688 | 5,938 | 3,359 | 2,889 | 1,401 | NA | 64 | 11,970 | 1,643 | 460 | 0 | | | 34,272 | 5,002 | 4,101 |
| 2009 | 13,083 | NA | 602 | 3,083 | 2,003 | 1,584 | 1,189 | NA | 55 | 9,177 | 1,703 | 601 | 0 | | | 26,532 | 3,706 | 2,842 |
| 2010 | 13,693 | NA | 630 | 3,141 | 0 | 144 | 959 | NA | 44 | 7,570 | 563 | 362 | 2,689 | NA | 186 | 28,052 | 563 | 1,367 |
| 2011 | 10,863 | NA | 500 | 3,586 | 0 | 165 | 976 | NA | 45 | 14,677 | 2,246 | 885 | 2,540 | NA | 175 | 32,642 | 2,246 | 1,770 |
| 2012 | 8,189 | NA | 377 | 780 | 3,067 | 2,661 | 575 | NA | 26 | 7,017 | 0 | 253 | 421 | NA | 29 | 16,982 | 3,067 | 3,345 |

Appendix A.8.–Central British Columbia ISBM Chinook salmon landed catch (LC), releases (Rel.), and incidental mortality (IM).

| | Central British Columbia | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | First Nations | | | Net[2] | | | Troll[1,2] | | | Tidal Sport[3] | | | Freshwater Sport | | | Total | | |
| Year | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM |
| 1975 | NA | | | 40,985 | | | 135,470 | | | NA | | | NA | | | 176,455 | | |
| 1976 | NA | | | 32,669 | | | 145,204 | | | NA | | | NA | | | 177,873 | | |
| 1977 | 6,972 | | | 32,409 | | | 122,689 | | | 4,773 | | | 1,544 | | | 168,387 | | |
| 1978 | 7,944 | | | 35,708 | | | 91,025 | | | 5,694 | | | 1,770 | | | 142,141 | | |
| 1979 | 7,585 | | | 50,445 | | | 107,884 | | | 5,225 | | | 1,940 | | | 173,079 | | |
| 1980 | 6,240 | | | 27,715 | | | 95,377 | | | 4,802 | | | 988 | | | 135,122 | | |
| 1981 | 5,701 | | | 18,912 | | | 69,247 | | | 3,490 | | | 1,261 | | | 98,611 | | |
| 1982 | 9,112 | | | 32,419 | | | 69,748 | | | 5,419 | | | 1,293 | | | 117,991 | | |
| 1983 | 6,442 | | | 12,556 | | | 97,447 | | | 4,271 | | | 821 | | | 121,537 | | |
| 1984 | 9,736 | | | 4,630 | | | 78,120 | | | 4,354 | | | 1,332 | | | 98,172 | | |
| 1985 | 6,019 | | | 12,391 | | | 27,090 | | | 3,943 | | | 823 | | | 50,266 | | |
| 1986 | 6,353 | | | 23,032 | | | 54,407 | | | 4,566 | | | 1,245 | | | 89,603 | | |
| 1987 | 6,296 | | | 10,893 | | | 65,776 | | | 3,933 | | | 1,563 | | | 88,461 | | |
| 1988 | 6,000 | | | 12,886 | | | 36,125 | | | 3,596 | | | 1,496 | | | 60,103 | | |
| 1989 | 8,992 | | | 6,599 | | | 21,694 | | | 3,438 | | | 4,526 | | | 45,249 | | |
| 1990 | 9,811 | | | 18,630 | | | 29,882 | | | 4,053 | | | 5,626 | | | 68,002 | | |
| 1991 | 8,801 | | | 15,926 | | | 29,843 | | | 4,409 | | | 3,335 | | | 62,314 | | |
| 1992 | 8,533 | | | 18,337 | | | 47,868 | | | 4,891 | | | 3,204 | | | 82,833 | | |
| 1993 | 9,095 | | | 10,579 | | | 23,376 | | | 6,114 | | | 2,880 | | | 52,044 | | |
| 1994 | 5,383 | | | 14,424 | | | 18,976 | | | 4,303 | | | 973 | | | 44,059 | | |
| 1995 | 3,501 | | | 11,007 | | | 5,819 | | | 2,172 | | | 1,180 | | | 23,679 | | |

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| | Central British Columbia | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | First Nations | | | Net[2] | | | Troll[1,2] | | | Tidal Sport[3] | | | Freshwater Sport | | | Total | | |
| Year | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM |
| 1996 | 6,922 | | | 7,201 | | | 0 | | | 2,936 | | | 3,986 | | | 21,045 | | |
| 1997 | 9,764 | | | 3,650 | | | 9,274 | | | 8,524 | | | 1,139 | | | 32,351 | | |
| 1998 | 6,671 | | | 5,467 | | | 2,188 | | | 5,514 | | | 779 | | | 20,619 | | |
| 1999 | 5,440 | | | 4,342 | | | 2,073 | | | 10,300 | | | NA | | | 22,155 | | |
| 2000 | 4,576 | | | 3,197 | | | 0 | | | 7,400 | | | NA | | | 15,173 | | |
| 2001 | 5,435 | | | 6,465 | | | 482 | | | 7,650 | | | 1,024 | | | 21,056 | | |
| 2002 | 3,292 | | | 4,676 | | | 0 | | | 7,330 | | | 723 | | | 16,021 | | |
| 2003 | 3,173 | | | 2,815 | | | 0 | | | 8,385 | 146 | 325 | 491 | | | 14,864 | 146 | 325 |
| 2004 | 4,003 | | | 5,404 | | | 0 | | | 10,677 | 77 | 397 | 524 | | | 20,608 | 77 | 397 |
| 2005 | 4,180 | | 192 | 6,323 | 15,281 | 11,298 | 0 | | 0 | 9,017 | 302 | 373 | 809 | | 56 | 20,329 | 15,583 | 11,919 |
| 2006 | 4,013 | | 185 | 5,231 | 1,391 | 1,247 | 0 | 786 | 160 | 9,400 | 428 | 406 | NA | | 60 | 18,644 | 2,605 | 2,058 |
| 2007 | 2,102 | | 97 | 5,542 | 5,349 | 4,106 | 0 | 1,804 | 371 | 6,130 | 118 | 239 | 522 | 20 | 40 | 14,296 | 7,291 | 4,853 |
| 2008 | 3,018 | | 139 | 1,133 | 181 | 183 | 9 | 757 | 155 | 2,909 | 607 | 201 | 276 | | 19 | 7,345 | 1,545 | 697 |
| 2009 | 4,011 | | 185 | 3,132 | 0 | 144 | 0 | 0 | 0 | 3,239 | 0 | 117 | 0 | | 38 | 10,382 | 0 | 483 |
| 2010 | 3,710 | | 171 | 1,549 | 0 | 71 | 0 | 0 | 0 | 4,043 | 0 | 146 | NA | | 45 | 9,302 | 0 | 432 |
| 2011 | 2,323 | | 107 | 4,794 | 0 | 221 | 0 | 0 | 0 | 7,701 | 498 | 356 | 646 | | 45 | 15,464 | 498 | 728 |
| 2012 | 1,745 | | 80 | 3,624 | 500 | 533 | 0 | 0 | 0 | 5,861 | 0 | 211 | 524 | | 36 | 11,754 | 500 | 860 |

[1] Since 1998, the catch accounting year for troll fisheries was set from October 1 to September 30. To make comparisons to previous years more meaningful, the same catch accounting period was applied for years prior to 1998.

[2] Troll and net catches from 1996 to 2004 have been updated with data from CDFO (2009), catch excludes jacks and small red-fleshed Chinook salmon.

[3] Freshwater catch included with tidal catch.

Appendix A.9.–West Coast Vancouver Island (WCVI) AABM Chinook salmon catches.

| | **West Coast Vancouver Island AABM** | | |
|---|---|---|---|
| **Year** | **Troll[1,2]** | **AABM Sport[3]** | **Total** |
| 1975 | 546,214 | – | 546,214 |
| 1976 | 665,010 | – | 665,010 |
| 1977 | 545,742 | – | 545,742 |
| 1978 | 568,705 | – | 568,705 |
| 1979 | 477,222 | – | 477,222 |
| 1980 | 486,303 | – | 486,303 |
| 1981 | 423,266 | – | 423,266 |
| 1982 | 538,510 | – | 538,510 |
| 1983 | 395,636 | – | 395,636 |
| 1984 | 471,294 | – | 471,294 |
| 1985 | 345,937 | – | 345,937 |
| 1986 | 350,227 | – | 350,227 |
| 1987 | 378,931 | – | 378,931 |
| 1988 | 408,668 | – | 408,668 |
| 1989 | 203,751 | – | 203,751 |
| 1990 | 297,858 | – | 297,858 |
| 1991 | 203,035 | – | 203,035 |
| 1992 | 340,146 | 18,518 | 358,664 |
| 1993 | 277,033 | 23,312 | 300,345 |
| 1994 | 150,039 | 10,313 | 160,352 |
| 1995 | 81,454 | 13,956 | 95,410 |
| 1996 | 4 | 10,229 | 10,233 |
| 1997 | 52,688 | 6,400 | 59,088 |
| 1998 | 5,140 | 4,177 | 9,317 |
| 1999 | 7,434 | 31,106 | 38,540 |
| 2000 | 64,547 | 24,070 | 88,617 |
| 2001 | 79,668 | 40,636 | 120,304 |
| 2002 | 126,383 | 31,503 | 157,886 |
| 2003 | 146,736 | 26,825 | 173,561 |
| 2004 | 176,166 | 39,086 | 215,252 |
| 2005 | 148,798 | 50,681 | 199,479 |
| 2006 | 108,978 | 36,507 | 145,485 |
| 2007 | 94,291 | 46,323 | 140,614 |
| 2008 | 95,170 | 50,556 | 145,726 |
| 2009 | 58,191 | 66,426 | 124,617 |
| 2010 | 84,123 | 54,924 | 139,047 |
| 2011 | 129,023 | 75,209 | 204,232 |
| 2012[4] | 69,054 | 65,414 | 134,468 |

*Note*: Troll= Areas 21, 23–27, and 121–127; Net = Areas 21, and 23–27; Sport = Areas 23a, 23b, 24–27.

[1] Since 1998, the catch accounting year for troll fisheries was set from October 1 to September 30. The same catch accounting period was applied for years prior to 1998.

[2] Troll catches from 1996 to 2004 have been updated with data from CDFO (2009).

[3] AABM sport catch 1975 to 1991 is under review. No estimate available; it is currently included in ISBM catch in Appendix A.11.

[4] Including 5,000 First Nations troll catch, 2,232 Maanulth Treaty catch and 6,292 T'aaq-wiihak troll catch.

Appendix A.10.–Estimates of incidental mortality associated with West Coast Vancouver Island (WCVI) AABM Chinook salmon catches.

| Year | Troll[1,2] |  | Outside Sport[3] |  | Total |
|---|---|---|---|---|---|
|  | LIM | SIM | LIM | SIM | IM |
| 1985 | 7,261 | 102,749 |  |  | 110,010 |
| 1986 | 5,954 | 66,075 |  |  | 72,029 |
| 1987 | 11,169 | 148,659 |  |  | 159,828 |
| 1988 | 16,283 | 169,260 |  |  | 185,543 |
| 1989 | 3,464 | 63,325 |  |  | 66,789 |
| 1990 | 5,064 | 91,521 |  |  | 96,585 |
| 1991 | 3,452 | 84,116 |  |  | 87,568 |
| 1992 | 5,782 | 95,732 |  |  | 101,514 |
| 1993 | 4,710 | 84,325 | 3,078 | 1,074 | 93,187 |
| 1994 | 2,551 | 76,372 | 1,217 | 475 | 80,615 |
| 1995 | 6,622 | 45,231 | 1,531 | 643 | 54,027 |
| 1996[4,5] |  |  |  |  |  |
| 1997[4,5] |  |  |  |  |  |
| 1998[4,5] |  |  |  |  |  |
| 1999[4] | 126 | 432 | 4,272 | 17,081 | 21,911 |
| 2000[4] | 1,097 | 2,455 | 2,626 | 3,629 | 9,807 |
| 2001[4] | 2,321 | 3,601 | 4,397 | 3,271 | 13,590 |
| 2002[4] | 3,754 | 5,329 | 4,540 | 1,441 | 15,064 |
| 2003[4] | 2,509 | 6,126 | 6,297 | 1,216 | 16,148 |
| 2004[4] | 2,995 | 4,127 | 5,781 | 1,053 | 13,956 |
| 2005 | 2,641 | 4,088 | 7,207 | 878 | 14,814 |
| 2006 | 2,565 | 3,031 | 4,800 | 1,161 | 11,557 |
| 2007 | 1,653 | 3,414 | 4,343 | 2,993 | 12,403 |
| 2008 | 1,631 | 2,863 | 6,269 | 1,549 | 12,312 |
| 2009 | 1,059 | 1,653 | 7,755 | 5,350 | 15,817 |
| 2010 | 1,506 | 1,936 | 10,679 | 1,896 | 16,017 |
| 2011 | 2,281 | 2,313 | 9,660 | 2,751 | 17,005 |
| 2012[6] | 1,214 | 629 | 10,976 | 3,571 | 16,390 |

*Note:* Troll = Areas 21, 23–27, and 121–127; Net = Areas 21, and 23–27; Sport = Areas 23a, 23b, 24–27

[1] Since 1998, the catch accounting year for troll fisheries was set from October 1 to September 30. The same catch accounting period was applied for years prior to 1998.

[2] Troll and net catches from 1996 to 2004 have been updated with data from CDFO, 2009.

[3] Prior to 1992, catch was not reported as inside or outside. Therefore inside catch for those years represents total tidal sport catch.

[4] First Nations catch is mainly commercial catch 1996–2004 has been updated.

[5] Release data are not yet available for 1996–1998.

[6] Including 5,000 First Nations troll catch, 2,232 Maanulth Treaty catch and 6,292 T'aaq-wiihak troll catch.

Appendix A.11.–West Coast Vancouver Island (WCVI) ISBM Chinook salmon landed catch (LC), releases (Rel.), and incidental mortality (IM).

| | West Coast Vancouver Island ISBM | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | First Nations[1] | | | Net[2] | | | Tidal Sport[3] | | | Freshwater Sport | | | Total | | |
| Year | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM |
| 1975 | NA | | | 19,233 | | | NA | | | NA | | | 19,233 | 0 | 0 |
| 1976 | NA | | | 17,492 | | | NA | | | NA | | | 17,492 | 0 | 0 |
| 1977 | NA | | | 13,745 | | | NA | | | NA | | | 13,745 | 0 | 0 |
| 1978 | NA | | | 25,143 | | | NA | | | NA | | | 25,143 | 0 | 0 |
| 1979 | NA | | | 35,623 | | | 7,964 | | | NA | | | 43,587 | 0 | 0 |
| 1980 | NA | | | 34,732 | | | 8,539 | | | NA | | | 43,271 | 0 | 0 |
| 1981 | NA | | | 36,411 | | | 11,230 | | | NA | | | 47,641 | 0 | 0 |
| 1982 | NA | | | 41,172 | | | 17,100 | | | NA | | | 58,272 | 0 | 0 |
| 1983 | NA | | | 37,535 | | | 28,000 | | | NA | | | 65,535 | 0 | 0 |
| 1984 | NA | | | 43,792 | | | 44,162 | | | NA | | | 87,954 | 0 | 0 |
| 1985 | NA | | | 11,089 | | | 21,587 | | | NA | | | 32,676 | 0 | 0 |
| 1986 | NA | | | 3,276 | | | 13,158 | | | NA | | | 16,434 | 0 | 0 |
| 1987 | NA | | | 478 | | | 38,283 | | | NA | | | 38,761 | 0 | 0 |
| 1988 | NA | | | 15,438 | | | 35,820 | | | NA | | | 51,258 | 0 | 0 |
| 1989 | NA | | | 40,321 | | | 55,239 | | | NA | | | 95,560 | 0 | 0 |
| 1990 | 1,199 | | | 29,578 | | | 69,723 | | | NA | | | 188,102 | 0 | 0 |
| 1991 | 41,322 | | | 60,797 | | | 85,983 | | | NA | | | 64,769 | 0 | 0 |
| 1992 | 8,315 | | | 9,486 | | | 46,968 | 28,322 | 8,679 | NA | | | 99,376 | 28,322 | 8,679 |
| 1993 | 5,078 | | | 28,694 | | | 65,604 | 37,263 | 11,681 | NA | | | 56,410 | 37,263 | 11,681 |
| 1994 | 1,515 | | | 2,369 | | | 52,526 | 26,000 | 8,616 | NA | | | 28,001 | 26,000 | 8,616 |
| 1995 | 5,868 | | | 458 | | | 21,675 | 9,797 | 3,377 | NA | | | 2,324 | 9,797 | 3,377 |

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Appendix A.11.–Page 2 of 2.

| Year | West Coast Vancouver Island ISBM | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | First Nations[1] | | | Net[2] | | | Tidal Sport[3] | | | Freshwater Sport | | | Total | | |
| | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM |
| 1996 | – | | | 58 | | | 2,266 | 544 | 261 | NA | | | 53,241 | 544 | 261 |
| 1997 | 5,678 | | | 208 | | | 47,355 | 11,365 | 5,450 | NA | | | 63,214 | 11,365 | 5,450 |
| 1998 | 7,172 | | | 345 | | | 55,697 | 13,367 | 6,410 | NA | | | 50,866 | 13,367 | 6,410 |
| 1999 | 3,591 | | | 112 | | | 47,163 | 11,319 | 5,428 | NA | | | 5,569 | 11,319 | 5,428 |
| 2000 | – | | | 126 | | | 5,443 | 13,954 | 3,055 | NA | | | 12,563 | 13,954 | 3,055 |
| 2001 | – | | | 11 | | | 6,354 | 10,684 | 2,490 | 6,198 | | | 47,195 | 10,684 | 2,490 |
| 2002 | 10,785 | | | 260 | | | 36,073 | 14,629 | 5,298 | 77 | | | 70,437 | 14,629 | 5,298 |
| 2003 | 10,000 | | | 9,251 | | | 51,186 | 25,341 | 8,397 | NA | | | 90,288 | 25,341 | 8,397 |
| 2004 | 16,696 | | | 12,348 | | | 61,218 | 29,852 | 9,956 | 26 | | | 108,401 | 29,852 | 9,956 |
| 2005 | 35,000 | | 1,610 | 23,599 | 354 | 4,687 | 43,577 | 9,534 | 4,837 | 6,225 | | 430 | 92,961 | 9,888 | 11,564 |
| 2006 | 28,628 | | 1,239 | 20,308 | 228 | 2,584 | 44,025 | 9,638 | 4,888 | NA | | 0 | 86,347 | 9,866 | 8,711 |
| 2007 | 20,098 | | 925 | 26,881 | 88 | 4,031 | 39,368 | 12,060 | 5,032 | NA | | 0 | 45,271 | 12,148 | 9,987 |
| 2008 | 12,159 | | 559 | 8,257 | 2 | 2,677 | 24,855 | 8,914 | 3,426 | NA | | 0 | 50,712 | 8,916 | 6,663 |
| 2009 | 9,026 | | 415 | 9,765 | 0 | 2,201 | 31,921 | 16,641 | 5,398 | NA | | 0 | 33,919 | 16,641 | 8,014 |
| 2010 | 7,485 | | 344 | 1,747 | 372 | 372 | 24,687 | 12,721 | 4,146 | NA | | 0 | 96,768 | 13,093 | 4,862 |
| 2011 | 22,794 | | 1,049 | 21,843 | 355 | 1,337 | 52,131 | 15,539 | 6,581 | NA | | 0 | 45,804 | 15,894 | 8,967 |
| 2012 | 9,700 | | 446 | 10,214 | 521 | 917 | 25,890 | 13,047 | 4,291 | NA | | 0 | 45,804 | 13,568 | 5,654 |

[1] First Nations catch is mainly commercial catch, 1996 to 2004 has been updated.

[2] Net catches from 1996 to 2004 have been updated with data from CDFO (2009).

[3] Prior to 1992, catch was not reported as inside or outside. Therefore inside catch for those years represents total tidal sport catch.

Appendix A.12.–Johnstone Strait ISBM Chinook salmon landed catch (LC), releases (Rel.), and incidental mortality (IM).

| | Johnstone Strait | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | First Nations | | | Net[1] | | | Troll[1,2] | | | Tidal Sport[3] | | | Total | | |
| Year | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM |
| 1975 | NA | | | 30,295 | | | 18,065 | | | NA | | | 48,360 | 0 | 0 |
| 1976 | NA | | | 31,855 | | | 30,838 | | | NA | | | 62,693 | 0 | 0 |
| 1977 | NA | | | 49,511 | | | 26,868 | | | NA | | | 76,379 | 0 | 0 |
| 1978 | NA | | | 55,148 | | | 13,052 | | | NA | | | 68,200 | 0 | 0 |
| 1979 | NA | | | 31,291 | | | 13,052 | | | NA | | | 44,343 | 0 | 0 |
| 1980 | NA | | | 30,325 | | | 11,743 | | | NA | | | 42,068 | 0 | 0 |
| 1981 | NA | | | 28,620 | | | 13,035 | | | NA | | | 41,655 | 0 | 0 |
| 1982 | NA | | | 29,454 | | | 11,234 | | | NA | | | 40,688 | 0 | 0 |
| 1983 | NA | | | 28,364 | | | 14,653 | | | NA | | | 43,017 | 0 | 0 |
| 1984 | NA | | | 18,361 | | | 9,260 | | | NA | | | 27,621 | 0 | 0 |
| 1985 | NA | | | 38,073 | | | 3,567 | | | NA | | | 41,640 | 0 | 0 |
| 1986 | NA | | | 17,866 | | | 3,951 | | | NA | | | 21,817 | 0 | 0 |
| 1987 | NA | | | 13,863 | | | 1,780 | | | NA | | | 15,643 | 0 | 0 |
| 1988 | NA | | | 6,292 | | | 1,566 | | | NA | | | 7,858 | 0 | 0 |
| 1989 | NA | | | 29,486 | | | 1,825 | | | NA | | | 31,311 | 0 | 0 |
| 1990 | NA | | | 18,433 | | | 2,298 | | | NA | | | 20,731 | 0 | 0 |
| 1991 | 1,287 | | | 15,071 | | | 1,228 | | | 9,311 | | | 26,897 | 0 | 0 |
| 1992 | 29 | | | 9,571 | | | 2,721 | | | 15,470 | | | 27,791 | 0 | 0 |
| 1993 | 20 | | | 15,530 | | | 4,172 | | | 12,679 | | | 32,401 | 0 | 0 |
| 1994 | 0 | | | 8,991 | | | 2,231 | | | 5,433 | | | 16,655 | 0 | 0 |
| 1995 | 71 | | | 970 | | | 4 | | | 4,296 | | | 5,341 | 0 | 0 |
| 1996 | 107 | | | 472 | | | 0 | | | 3,057 | | | 3,636 | 0 | 0 |

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Appendix A.12.–Page 2 of 2.

| Year | Johnstone Strait | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | First Nations | | | Net[1] | | | Troll[1,2] | | | Tidal Sport[3] | | | Total | | |
| | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM |
| 1997 | 179 | | | 1,018 | | | 1,246 | | | 4,047 | | | 6,490 | 0 | 0 |
| 1998 | 138 | | | 328 | | | 2,129 | | | 2,710 | | | 5,305 | 0 | 0 |
| 1999 | 469 | | | 472 | | | 273 | | | 8,985 | | | 10,199 | 0 | 0 |
| 2000 | 212 | | | 280 | | | 85 | | | 5,960 | | | 6,537 | 0 | 0 |
| 2001 | 370 | | | 332 | | | 453 | | | 4,150 | | | 5,305 | 0 | 0 |
| 2002 | 400 | | | 569 | | | 129 | | | 3,696 | | | 4,794 | 0 | 0 |
| 2003 | 130 | | | 306 | | | 719 | | | 9,851 | | | 11,006 | 0 | 0 |
| 2004 | 28 | | | 525 | | | 316 | | | 16,131 | | | 17,000 | 0 | 0 |
| 2005 | NA | NA | 0 | 291 | 1,925 | 1,596 | 2 | 0 | 0 | 16,076 | 9,522 | 2,937 | 16,369 | 11,447 | 4,533 |
| 2006 | 200 | NA | 9 | 244 | 5,304 | 4,073 | 0 | 612 | 135 | 10,532 | 4,526 | 1,596 | 10,976 | 10,442 | 5,813 |
| 2007 | 200 | NA | 9 | 2 | 331 | 304 | 0 | 293 | 68 | 9,882 | 5,814 | 1,798 | 10,084 | 6,438 | 2,179 |
| 2008 | 324 | NA | 15 | 48 | 447 | 325 | 0 | 0 | 0 | 4,436 | 3,985 | 1,071 | 4,808 | 4,432 | 1,411 |
| 2009 | 344 | NA | 16 | 597 | 14 | 426 | 0 | 0 | 0 | 11,501 | 15,984 | 3,862 | 12,442 | 15,998 | 4,304 |
| 2010 | 250 | NA | 12 | 98 | 2,908 | 2,278 | 2 | 428 | 101 | 10,016 | 9,092 | 2,437 | 10,366 | 12,428 | 4,827 |
| 2011 | 268 | NA | 12 | 46 | 2,312 | 1,710 | 0 | 36 | 7 | 11,934 | 5,169 | 1,816 | 12,248 | 7,517 | 3,546 |
| 2012 | 321 | NA | 15 | 37 | 468 | 346 | 0 | 44 | 9 | 7,874 | 7,899 | 2,060 | 8,232 | 8,411 | 2,429 |

*Note*: Troll = Area 12; Net = Areas 11–13.

*Note*: Sport: Based on July and August creel census in Area 12 and northern half of Area 13.

[1] Troll and net catches from 1996 to 2004 have been updated with data from CDFO (2009).

[2] Since 1998, the catch accounting year for troll fisheries was set from October 1 to September 30. The same catch accounting period was applied for years prior to 1998.

[3] Tidal sport creel catches include additional catch estimated using Argue et al., 1977.

Appendix A.13.–Georgia Strait ISBM Chinook salmon landed catch (LC), releases (Rel.), and incidental mortality (IM).

| | Georgia Strait | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | First Nations | | | Net[1] | | | Troll[1,2] | | | Tidal Sport | | | Total | | |
| Year | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM |
| 1975 | | | | | | | 174,001 | | | 398,000 | | | 572,001 | 0 | 0 |
| 1976 | | | | | | | 200,229 | | | 490,000 | | | 690,229 | 0 | 0 |
| 1977 | | | | | | | 248,082 | | | 372,000 | | | 620,082 | 0 | 0 |
| 1978 | | | | | | | 217,955 | | | 500,000 | | | 717,955 | 0 | 0 |
| 1979 | | | | | | | 255,057 | | | 350,000 | | | 605,057 | 0 | 0 |
| 1980 | | | | | | | 273,077 | | | 204,100 | | | 477,177 | 0 | 0 |
| 1981 | | | | | | | 239,266 | | | 197,239 | | | 436,505 | 0 | 0 |
| 1982 | | | | | | | 179,040 | | | 124,390 | | | 303,430 | 0 | 0 |
| 1983 | | | | | | | 105,133 | | | 198,433 | | | 303,566 | 0 | 0 |
| 1984 | | | | | | | 90,280 | | | 369,445 | | | 459,725 | 0 | 0 |
| 1985 | | | | | | | 55,888 | | | 234,838 | | | 290,726 | 0 | 0 |
| 1986 | | | | | | | 44,043 | | | 181,896 | | | 225,939 | 0 | 0 |
| 1987 | | | | | | | 38,084 | | | 121,081 | | | 159,165 | 0 | 0 |
| 1988 | | | | | | | 20,224 | | | 119,117 | | | 139,341 | 0 | 0 |
| 1989 | | | | | | | 28,444 | | | 132,846 | | | 161,290 | 0 | 0 |
| 1990 | | | | | | | 34,304 | | | 111,914 | | | 146,218 | 0 | 0 |
| 1991 | | | | | | | 32,412 | | | 115,523 | | | 147,935 | 0 | 0 |
| 1992 | | | | | | | 37,250 | | | 116,581 | | | 153,831 | 0 | 0 |
| 1993 | | | | | | | 33,293 | | | 127,576 | | | 160,869 | 0 | 0 |
| 1994 | | | | | | | 12,916 | | | 70,839 | | | 83,755 | 0 | 0 |
| 1995 | | | | | | | 138 | | | 62,173 | | | 62,311 | 0 | 0 |
| 1996 | | | | 8 | | | 14 | | | 89,589 | | | 89,611 | 0 | 0 |

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Appendix A.13.–Page 2 of 2.

| Year | Georgia Strait | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | First Nations | | | Net[1] | | | Troll[1,2] | | | Tidal Sport | | | Total | | |
| | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM |
| 1997 | | | | 1 | | | 806 | | | 56,332 | | | 57,139 | 0 | 0 |
| 1998 | | | | 11 | | | 303 | | | 20,923 | | | 21,237 | 0 | 0 |
| 1999 | | | | 0 | | | 219 | | | 43,588 | | | 43,807 | 0 | 0 |
| 2000 | | | | 0 | | | 609 | | | 32,750 | | | 33,359 | 0 | 0 |
| 2001 | | | | 3 | 708 | 512 | 311 | 169 | 39 | 31,259 | | | 31,573 | 877 | 551 |
| 2002 | | | | 16 | 601 | 446 | 459 | 205 | 49 | 52,979 | | | 53,454 | 806 | 496 |
| 2003 | | | | 18 | 1,368 | 999 | 279 | 189 | 43 | 19,981 | | | 20,278 | 1,557 | 1,042 |
| 2004 | | | | 0 | 881 | 645 | 389 | 235 | 54 | 13,475 | | | 13,864 | 1,116 | 699 |
| 2005 | | | | 20 | 703 | 485 | 0 | 206 | 42 | 11,972 | 10,102 | 2,766 | 11,992 | 11,011 | 3,293 |
| 2006 | | | | 0 | 3 | 3 | 0 | 3 | 1 | 12,181 | 4,730 | 1,749 | 12,181 | 4,736 | 1,752 |
| 2007 | | | | 0 | 200 | 144 | 0 | 0 | 0 | 14,561 | 25,595 | 5,919 | 14,561 | 25,795 | 6,063 |
| 2008 | 4,848 | | 223 | 0 | 156 | 112 | 0 | 0 | 0 | 8,836 | 8,772 | 2,294 | 13,684 | 8,928 | 2,629 |
| 2009 | 0 | 0 | 0 | 239 | 0 | 171 | 0 | 135 | 0 | 17,884 | 21,644 | 5,390 | 18,123 | 21,779 | 5,561 |
| 2010 | 40 | | 2 | 54 | 1,128 | 863 | 5 | 359 | 85 | 14,942 | 13,704 | 3,662 | 15,041 | 15,191 | 4,613 |
| 2011 | 2,379 | 17 | 126 | 3 | 113 | 86 | 0 | 177 | 36 | 21,651 | 20,327 | 5,397 | 24,033 | 20,634 | 5,644 |
| 2012 | 3,096 | | 142 | 0 | 0 | 0 | 0 | 0 | 0 | 22,457 | 45,785 | 10,340 | 25,553 | 45,785 | 10,483 |

*Note*: Troll = Areas 13–18; Net = Areas 14–19; Sport = Areas 13–18, 19a.

[1] Troll and net catches from 1996–2004 have been updated with data from CDFO (2009).

[2] Since 1998, the catch accounting year for troll fisheries was set from October 1 to September 30. The same catch accounting period was applied for years prior to 1998.

Appendix A.14.–Fraser River ISBM Chinook salmon landed catch (LC), releases (Rel.), and incidental mortality (IM).

| | Fraser River Watershed | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | First Nations[1] | | | Net[2] | | | Freshwater Sport[3,4] | | | Total | | |
| Year | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM |
| 1975 | 20,170 | | | 66,119 | | | 7,740 | | | 94,029 | 0 | 0 |
| 1976 | 19,189 | | | 73,018 | | | 6,354 | | | 98,561 | 0 | 0 |
| 1977 | 23,310 | | | 85,222 | | | 3,071 | | | 111,603 | 0 | 0 |
| 1978 | 19,541 | | | 50,247 | | | 3,627 | | | 73,415 | 0 | 0 |
| 1979 | 10,217 | | | 51,488 | | | 4,450 | | | 66,155 | 0 | 0 |
| 1980 | 10,528 | | | 40,061 | | | 7 | | | 50,596 | 0 | 0 |
| 1981 | 8,389 | | | 22,447 | | | 0 | | | 30,836 | 0 | 0 |
| 1982 | 29,043 | | | 23,792 | | | 96 | | | 52,931 | 0 | 0 |
| 1983 | 11,875 | | | 25,580 | | | 0 | | | 37,455 | 0 | 0 |
| 1984 | 17,111 | | | 27,929 | | | 80 | | | 45,120 | 0 | 0 |
| 1985 | 8,387 | | | 28,894 | | | 596 | | | 37,877 | 0 | 0 |
| 1986 | 12,274 | | | 31,401 | | | 1,421 | | | 45,096 | 0 | 0 |
| 1987 | 12,050 | | | 12,021 | | | 3,561 | | | 27,632 | 0 | 0 |
| 1988 | 12,063 | | | 8,446 | | | 3,702 | | | 24,211 | 0 | 0 |
| 1989 | 4,784 | | | 23,443 | | | 2,500 | | | 30,727 | 0 | 0 |
| 1990 | 14,180 | | | 15,689 | | | 2,982 | | | 32,851 | 0 | 0 |
| 1991 | 13,950 | | | 14,757 | | | 3,116 | | | 31,823 | 0 | 0 |
| 1992 | 10,067 | | | 7,363 | | | 4,677 | | | 22,107 | 0 | 0 |
| 1993 | 15,395 | | | 13,885 | | | 3,430 | | | 32,710 | 0 | 0 |
| 1994 | 17,892 | | | 13,693 | | | 3,195 | | | 34,780 | 0 | 0 |
| 1995 | 17,791 | | | 6,451 | | | 8,258 | | | 32,500 | 0 | 0 |
| 1996 | 12,665 | | | 12,910 | | | 7,635 | | | 33,210 | 0 | 0 |

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Appendix A.14.–Page 2 of 2.

| | Fraser River Watershed | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | First Nations[1] | | | Net[2] | | | Freshwater Sport[3,4] | | | Total | | |
| Year | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM |
| 1997 | 13,453 | | | 40,877 | | | 5,051 | | | 59,381 | 0 | 0 |
| 1998 | 14,702 | | | 8,292 | | | 18,073 | | | 41,067 | 0 | 0 |
| 1999 | 17,999 | | | 4,043 | | | 8,509 | | | 30,551 | 0 | 0 |
| 2000 | 20,839 | | | 8,244 | | | 12,836 | | | 41,919 | 0 | 0 |
| 2001 | 18,429 | | | 10,398 | 28 | 26 | 25,023 | | | 53,850 | 28 | 26 |
| 2002 | 21,796 | | | 9,732 | 329 | 281 | 24,355 | | | 55,883 | 329 | 281 |
| 2003 | 28,137 | | | 11,204 | 287 | 272 | 19,520 | | | 58,861 | 287 | 272 |
| 2004 | 31,165 | | | 19,224 | 197 | 186 | 18,581 | | | 68,970 | 197 | 186 |
| 2005 | 19,832 | 0 | 879 | 9,088 | 97 | 335 | 22,688 | 13,322 | 2,720 | 51,608 | 13,419 | 3,934 |
| 2006 | 14,793 | 333 | 950 | 7,686 | 61 | 213 | 26,662 | 550 | 1,062 | 49,141 | 944 | 2,225 |
| 2007 | 13,714 | 759 | 1,333 | 6,795 | 44 | 166 | 12,945 | 8,694 | 1,586 | 33,454 | 9,497 | 3,085 |
| 2008 | 22,417 | 96 | 973 | 4,575 | 89 | 276 | 18,597 | 13,810 | 3,366 | 45,589 | 13,995 | 4,615 |
| 2009 | 27,288 | 105 | 1,203 | 7,848 | 146 | 330 | 17,485 | 15,845 | 3,611 | 52,621 | 16,096 | 5,143 |
| 2010 | 15,432 | 298 | 992 | 13,953 | 67 | 499 | 14,324 | 13,512 | 3,583 | 43,709 | 13,877 | 5,074 |
| 2011 | 33,118 | 96 | 1,614 | 17,989 | 104 | 351 | 20,349 | 9,022 | 3,136 | 71,456 | 9,222 | 5,101 |
| 2012 | 36,521 | 104 | 1,778 | 2,899 | 0 | 576 | 11,396 | 7,333 | 2,194 | 50,816 | 7,437 | 4,549 |

[1] First Nations Chinook salmon catch includes food, social and ceremonial from the mainstem and tributaries. Economic opportunity included in commercial net.

[2] Fraser River net includes commercial Area E Gillnet, test fisheries, First Nations economic opportunities and scientific licenses.

[3] Freshwater sport catch includes Fraser mainstem and tributary Chinook salmon catch (adults only).

[4] Updated 1975 to 1980 sport catch from Fraser et al. 1982.

Appendix A.15.–Canada– Strait of Juan de Fuca ISBM Chinook salmon landed catch (LC), releases (Rel.), and incidental mortality (IM).

| | Canada – Strait of Juan de Fuca | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | First Nations | | | Net[1] | | | Tidal Sport | | | Total | | |
| Year | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM |
| 1975 | NA | | | 9,799 | | | NA | | | 9,799 | 0 | 0 |
| 1976 | NA | | | 13,004 | | | NA | | | 13,004 | 0 | 0 |
| 1977 | NA | | | 25,344 | | | NA | | | 25,344 | 0 | 0 |
| 1978 | NA | | | 9,725 | | | NA | | | 9,725 | 0 | 0 |
| 1979 | NA | | | 8,665 | | | NA | | | 8,665 | 0 | 0 |
| 1980 | NA | | | 3,438 | | | 37,900 | | | 41,338 | 0 | 0 |
| 1981 | NA | | | 9,982 | | | 29,832 | | | 39,814 | 0 | 0 |
| 1982 | NA | | | 7,072 | | | 30,646 | | | 37,718 | 0 | 0 |
| 1983 | NA | | | 328 | | | 30,228 | | | 30,556 | 0 | 0 |
| 1984 | NA | | | 6,237 | | | 24,353 | | | 30,590 | 0 | 0 |
| 1985 | NA | | | 17,164 | | | 27,843 | | | 45,007 | 0 | 0 |
| 1986 | NA | | | 17,727 | | | 34,387 | | | 52,114 | 0 | 0 |
| 1987 | NA | | | 6,782 | | | 24,878 | | | 31,660 | 0 | 0 |
| 1988 | NA | | | 4,473 | | | 31,233 | | | 35,706 | 0 | 0 |
| 1989 | NA | | | 21,238 | | | 32,539 | | | 53,777 | 0 | 0 |
| 1990 | 42 | | | 7,405 | | | 30,127 | | | 37,574 | 0 | 0 |
| 1991 | 250 | | | 8,893 | | | 19,017 | | | 28,160 | 0 | 0 |
| 1992 | 302 | | | 10,023 | | | 21,090 | | | 31,415 | 0 | 0 |
| 1993 | 317 | | | 2,287 | | | 13,967 | | | 16,571 | 0 | 0 |
| 1994 | 600 | | | 8,931 | | | 14,372 | | | 23,903 | 0 | 0 |
| 1995 | 751 | | | 631 | | | 14,405 | | | 15,787 | 0 | 0 |
| 1996 | 20 | | | 655 | | | 19,012 | | | 19,687 | 0 | 0 |
| 1997 | 42 | | | 657 | | | 17,080 | | | 17,779 | 0 | 0 |
| 1998 | 1,500 | | | 495 | | | 9,709 | | | 11,704 | 0 | 0 |
| 1999 | 52 | | | 771 | | | 14,808 | | | 15,631 | 0 | 0 |

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Appendix A.15.–Page 2 of 2.

| Year | Canada – Strait of Juan de Fuca | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | First Nations | | | Net[1] | | | Tidal Sport | | | Total | | |
| | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM |
| 2000 | 272 | | | 199 | | | 10,973 | | | 11,444 | 0 | 0 |
| 2001 | 135 | | | 439 | | | 23,463 | | | 24,037 | 0 | 0 |
| 2002 | NA | | | 345 | | | 24,084 | | | 24,429 | 0 | 0 |
| 2003 | NA | | | 292 | | | 26,630 | | | 26,922 | 0 | 0 |
| 2004 | NA | | | 187 | | | 40,877 | | | 41,064 | 0 | 0 |
| 2005 | NA | | | 153 | 0 | 110 | 30,480 | 11,857 | 4,380 | 30,633 | 11,857 | 4,490 |
| 2006 | NA | | | 155 | 801 | 606 | 26,437 | 5,079 | 2,799 | 26,592 | 5,880 | 3,405 |
| 2007 | NA | | | 138 | 690 | 534 | 26,549 | 11,832 | 4,104 | 26,687 | 12,522 | 4,638 |
| 2008 | NA | | | 172 | 573 | 442 | 22,263 | 6,540 | 2,792 | 22,435 | 7,113 | 3,234 |
| 2009 | NA | | | 385 | 0 | 277 | 25,587 | 44,169 | 10,246 | 25,972 | 44,169 | 10,523 |
| 2010 | NA | | | 206 | 1,239 | 920 | 15,612 | 4,868 | 2,012 | 15,818 | 6,107 | 2,932 |
| 2011 | NA | | | 278 | 1,522 | 1,166 | 21,075 | 12,878 | 3,927 | 21,353 | 14,400 | 5,093 |
| 2012 | NA | | | 284 | 1,124 | 853 | 22,154 | 10,603 | 3,564 | 22,438 | 11,727 | 4,417 |

*Note*: Net = Area 20; Sport = Areas 19b and 20.

[1] Net catches from 1996 to 2004 have been updated with data from CDFO (2009).

Appendix A.16.–Washington Strait of Juan de Fuca ISBM Chinook salmon landed catch (LC), releases (Rel.), and incidental mortality (IM).

| | Washington – Strait of Juan de Fuca | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Troll | | | Net | | | Sport | | | Total | | |
| Year | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM |
| 1975 | 5,752 | NA | 144 | 8,048 | NA | 644 | 81,681 | NA | 11,844 | 95,481 | NA | 12,631 |
| 1976 | 10,488 | NA | 262 | 6,072 | NA | 486 | 75,308 | NA | 10,920 | 91,868 | NA | 11,668 |
| 1977 | 8,915 | NA | 223 | 14,930 | NA | 1,194 | 53,238 | NA | 7,720 | 77,083 | NA | 9,137 |
| 1978 | 10,006 | NA | 250 | 11,224 | NA | 898 | 62,299 | NA | 9,033 | 83,529 | NA | 10,181 |
| 1979 | 7,804 | NA | 195 | 10,939 | NA | 875 | 67,094 | NA | 9,729 | 85,837 | NA | 10,799 |
| 1980 | 10,682 | NA | 267 | 11,320 | NA | 906 | 56,415 | NA | 8,180 | 78,417 | NA | 9,353 |
| 1981 | 15,638 | NA | 391 | 18,541 | NA | 1,483 | 51,352 | NA | 7,446 | 85,531 | NA | 9,320 |
| 1982 | 19,024 | NA | 476 | 22,547 | NA | 1,804 | 29,842 | NA | 4,327 | 71,413 | NA | 6,606 |
| 1983 | 18,489 | NA | 462 | 16,141 | NA | 1,291 | 58,060 | NA | 8,419 | 92,690 | NA | 10,172 |
| 1984 | 15,650 | NA | 391 | 12,120 | NA | 970 | 48,003 | NA | 6,960 | 75,773 | NA | 8,321 |
| 1985 | 11,808 | NA | 295 | 12,784 | NA | 1,023 | 44,267 | NA | 6,419 | 68,859 | NA | 7,737 |
| 1986 | 30,000 | NA | 750 | 17,000 | NA | 1,360 | 69,000 | NA | 10,005 | 116,000 | NA | 12,115 |
| 1987 | 45,000 | NA | 1,125 | 11,000 | NA | 880 | 53,000 | NA | 7,685 | 109,000 | NA | 9,690 |
| 1988 | 49,000 | NA | 1,225 | 10,000 | NA | 800 | 39,000 | NA | 5,655 | 98,000 | NA | 7,680 |
| 1989 | 65,000 | NA | 1,625 | 10,000 | NA | 800 | 52,000 | NA | 7,540 | 127,000 | NA | 9,965 |
| 1990 | 47,162 | NA | 1,179 | 5,294 | NA | 424 | 50,903 | NA | 7,381 | 103,359 | NA | 8,984 |
| 1991 | 37,127 | NA | 928 | 3,390 | NA | 271 | 39,667 | NA | 5,752 | 80,184 | NA | 6,951 |
| 1992 | 31,452 | NA | 786 | 927 | NA | 74 | 38,438 | NA | 5,574 | 70,817 | NA | 6,434 |
| 1993 | 9,794 | NA | 245 | 1,482 | NA | 119 | 32,434 | NA | 4,703 | 43,710 | NA | 5,066 |
| 1994 | 3,346 | NA | 84 | 5,864 | NA | 469 | 1,661 | NA | 241 | 10,871 | NA | 794 |
| 1995 | 6,397 | NA | 160 | 4,769 | NA | 382 | 6,349 | NA | 921 | 17,515 | NA | 1,462 |
| 1996 | 9,757 | NA | 244 | 604 | NA | 48 | 4,825 | NA | 700 | 15,186 | NA | 992 |

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Appendix A.16.–Page 2 of 2.

| Year | Washington – Strait of Juan de Fuca | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Troll | | | Net | | | Sport | | | Total | | |
| | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM |
| 1997 | 829 | NA | 21 | 492 | NA | 39 | 12,238 | NA | 1,775 | 13,559 | NA | 1,835 |
| 1998 | 338 | NA | 8 | 265 | NA | 21 | 2,159 | NA | 313 | 2,762 | NA | 343 |
| 1999 | 544 | NA | 14 | 589 | NA | 47 | 1,990 | NA | 289 | 3,123 | NA | 349 |
| 2000 | 332 | NA | 8 | 640 | NA | 51 | 1,670 | NA | 242 | 2,642 | NA | 302 |
| 2001 | 1,974 | NA | 49 | 931 | NA | 74 | 4,819 | NA | 699 | 7,724 | NA | 823 |
| 2002 | 1,783 | NA | 45 | 1,076 | NA | 86 | 2,028 | NA | 294 | 4,887 | NA | 425 |
| 2003 | 436 | NA | 11 | 908 | NA | 73 | 5,290 | 28201 | 8325 | 6,634 | 28,201 | 8,408 |
| 2004 | 20,627 | NA | 516 | 592 | NA | 47 | 4,519 | 22275 | 6625 | 25,738 | 22,275 | 7,188 |
| 2005 | 5,344 | NA | 134 | 175 | NA | 14 | 2,700 | 10189 | 3122 | 8,219 | 10,189 | 3,270 |
| 2006 | 1,115 | NA | 28 | 957 | NA | 77 | 5,695 | 14823 | 4798 | 7,767 | 14,823 | 4,903 |
| 2007 | 4,329 | NA | 108 | 107 | NA | 9 | 6,967 | 23133 | 7210 | 11,403 | 23,133 | 7,327 |
| 2008 | 1,816 | NA | 45 | 4,579 | NA | 366 | 4,844 | 13359 | 4283 | 11,239 | 13,359 | 4,694 |
| 2009 | 3,280 | NA | 82 | 99 | NA | 8 | 11,167 | 46047 | 13960 | 14,546 | 46,047 | 14,050 |
| 2010 | 2,011 | NA | 50 | 1,339 | NA | 107 | 11,508 | 38036 | 11862 | 14,858 | 38,036 | 12,020 |
| 2011 | 4,090 | NA | 102 | 352 | NA | 28 | 9,504 | 20601 | 6899 | 13,946 | 20,601 | 7,029 |
| 2012 | 1,026 | NA | 26 | 1523 | NA | 122 | 10,726[1] | 34,894[1] | 10,907[1] | 13,275 | 34,894 | 11,054 |

*Note*: Troll = Areas 5 and 6C, Area 4B from January 1 to April 30 and October 1 to December 31; Net = Areas 4B, 5, and 6C; Sport = Areas 5 and 6, 4B Neah Bay "add-on" fishery.

Note: NA = not available; for fisheries without estimate of releases, IM is drop-off/dropout only.

[1] Current year not available; values are average of previous three years.

Appendix A.17.–Washington–San Juan ISBM Chinook salmon landed catch (LC), releases (Rel.), and incidental mortality (IM).

| | Washington – San Juan | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Troll | | | Net | | | Sport | | | Total | | |
| Year | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM |
| 1975 | 3 | NA | 0 | 90,100 | NA | 7,208 | 31,988 | NA | 4,638 | 122,091 | NA | 11,846 |
| 1976 | 0 | NA | 0 | 66,832 | NA | 5,347 | 34,505 | NA | 5,003 | 101,337 | NA | 10,350 |
| 1977 | 62 | NA | 2 | 84,316 | NA | 6,745 | 14,049 | NA | 2,037 | 98,427 | NA | 8,784 |
| 1978 | 3 | NA | 0 | 87,565 | NA | 7,005 | 15,083 | NA | 2,187 | 102,651 | NA | 9,192 |
| 1979 | 5 | NA | 0 | 53,750 | NA | 4,300 | 17,367 | NA | 2,518 | 71,122 | NA | 6,818 |
| 1980 | 0 | NA | 0 | 64,338 | NA | 5,147 | 12,231 | NA | 1,773 | 76,569 | NA | 6,921 |
| 1981 | 4 | NA | 0 | 50,695 | NA | 4,056 | 9,727 | NA | 1,410 | 60,426 | NA | 5,466 |
| 1982 | 0 | NA | 0 | 38,763 | NA | 3,101 | 6,953 | NA | 1,008 | 45,716 | NA | 4,109 |
| 1983 | 2 | NA | 0 | 28,497 | NA | 2,280 | 15,166 | NA | 2,199 | 43,665 | NA | 4,479 |
| 1984 | 83 | NA | 2 | 33,432 | NA | 2,675 | 25,759 | NA | 3,735 | 59,274 | NA | 6,412 |
| 1985 | 872 | NA | 22 | 33,579 | NA | 2,686 | 12,610 | NA | 1,828 | 47,061 | NA | 4,537 |
| 1986 | 0 | NA | 0 | 21,000 | NA | 1,680 | 15,000 | NA | 2,175 | 36,000 | NA | 3,855 |
| 1987 | 0 | NA | 0 | 29,000 | NA | 2,320 | 14,000 | NA | 2,030 | 43,000 | NA | 4,350 |
| 1988 | 0 | NA | 0 | 32,000 | NA | 2,560 | 9,000 | NA | 1,305 | 41,000 | NA | 3,865 |
| 1989 | 1,000 | NA | 25 | 16,000 | NA | 1,280 | 9,000 | NA | 1,305 | 26,000 | NA | 2,610 |
| 1990 | 666 | NA | 17 | 8,608 | NA | 689 | 7,370 | NA | 1,069 | 16,644 | NA | 1,774 |
| 1991 | 135 | NA | 3 | 11,753 | NA | 940 | 5,115 | NA | 742 | 17,003 | NA | 1,685 |
| 1992 | 172 | NA | 4 | 14,011 | NA | 1,121 | 6,788 | NA | 984 | 20,971 | NA | 2,109 |
| 1993 | 243 | NA | 6 | 14,002 | NA | 1,120 | 6,916 | NA | 1,003 | 21,161 | NA | 2,129 |
| 1994 | 73 | NA | 2 | 13,908 | NA | 1,113 | 5,795 | NA | 840 | 19,776 | NA | 1,955 |
| 1995 | 9 | NA | 0 | 5,333 | NA | 427 | 7,863 | NA | 1,140 | 13,205 | NA | 1,567 |
| 1996 | 153 | NA | 4 | 3,934 | NA | 315 | 12,674 | NA | 1,838 | 16,761 | NA | 2,156 |
| 1997 | 29 | NA | 1 | 29,593 | NA | 2,367 | 9,155 | NA | 1,327 | 38,777 | NA | 3,696 |

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Appendix A.17.–Page 2 of 2.

| Year | Washington – San Juan | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Troll | | | Net | | | Sport | | | Total | | |
| | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM |
| 1998 | 376 | NA | 9 | 3,804 | NA | 304 | 3,069 | NA | 445 | 7,249 | NA | 759 |
| 1999 | 114 | NA | 3 | 3 | NA | 0 | 3,421 | NA | 496 | 3,538 | NA | 499 |
| 2000 | 22 | NA | 1 | 1,091 | NA | 87 | 4,447 | NA | 645 | 5,560 | NA | 733 |
| 2001 | 0 | NA | 0 | 970 | NA | 78 | 6,522 | NA | 946 | 7,492 | NA | 1,023 |
| 2002 | 0 | NA | 0 | 2,231 | NA | 178 | 4,827 | NA | 700 | 7,058 | NA | 878 |
| 2003 | 0 | NA | 0 | 4,827 | NA | 386 | 3,008 | 1646 | 877 | 7,835 | 1,646 | 1,264 |
| 2004 | 123 | NA | 3 | 5,184 | NA | 415 | 1,971 | 1190 | 605 | 7,278 | 1,190 | 1,022 |
| 2005 | 0 | NA | 0 | 4,358 | 491 | 741 | 2,703 | 1544 | 806 | 7,061 | 2,035 | 1,547 |
| 2006 | 0 | NA | 0 | 5,278 | 439 | 773 | 4,168 | 1278 | 947 | 9,446 | 1,717 | 1,720 |
| 2007 | 0 | NA | 0 | 2,621 | 476 | 590 | 4,955 | 3933 | 1773 | 7,576 | 4,409 | 2,363 |
| 2008 | 0 | NA | 0 | 48 | 76 | 65 | 5,829 | 2673 | 1562 | 5,877 | 2,749 | 1,626 |
| 2009 | 0 | NA | 0 | 1,014 | 2,012 | 1,691 | 4,077 | 5375 | 2032 | 5,091 | 7,387 | 3,722 |
| 2010 | 0 | NA | 0 | 5,950 | 4,972 | 4,454 | 3,157 | 2402 | 1102 | 9,107 | 7,374 | 5,555 |
| 2011 | 0 | NA | 0 | 5,810 | 11,893 | 9,979 | 6,193 | 6603 | 2668 | 12,003 | 18,496 | 12,647 |
| 2012 | 0 | NA | 0 | 441 | 218 | 210 | 4,476[1] | 4,793[1] | 1,934[1] | 4,917 | 5,011 | 2,144 |

*Note*: Troll = Areas 6, 6A, 7, and 7A; Net = Areas 6, 6A, 7 and 7A.

*Note*: NA = not available; for fisheries without estimate of releases, IM is dropoff/dropout only.

[1] Current year not available; values are average of previous three years.

Appendix A.18.–Washington–Other Puget Sound ISBM Chinook salmon landed catch (LC), releases (Rel.), and incidental mortality (IM).

| | **Washington – Other Puget Sound** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Net** | | | **Sport** | | | **Total** | | |
| **Year** | **LC** | **Rel.** | **IM** | **LC** | **Rel.** | **IM** | **LC** | **Rel.** | **IM** |
| 1975 | 131,982 | NA | 10,559 | 173,086 | NA | 25,097 | 305,068 | NA | 35,656 |
| 1976 | 141,281 | NA | 11,302 | 151,246 | NA | 21,931 | 292,527 | NA | 33,233 |
| 1977 | 145,470 | NA | 11,638 | 97,761 | NA | 14,175 | 243,231 | NA | 25,813 |
| 1978 | 150,298 | NA | 12,024 | 116,979 | NA | 16,962 | 267,277 | NA | 28,986 |
| 1979 | 128,073 | NA | 10,246 | 156,402 | NA | 22,678 | 284,475 | NA | 32,924 |
| 1980 | 171,516 | NA | 13,721 | 142,799 | NA | 20,706 | 314,315 | NA | 34,427 |
| 1981 | 145,152 | NA | 11,612 | 106,048 | NA | 15,377 | 251,200 | NA | 26,989 |
| 1982 | 149,274 | NA | 11,942 | 85,703 | NA | 12,427 | 234,977 | NA | 24,369 |
| 1983 | 134,492 | NA | 10,759 | 123,752 | NA | 17,944 | 258,244 | NA | 28,703 |
| 1984 | 180,248 | NA | 14,420 | 102,740 | NA | 14,897 | 282,988 | NA | 29,317 |
| 1985 | 184,907 | NA | 14,793 | 92,603 | NA | 13,427 | 277,510 | NA | 28,220 |
| 1986 | 153,000 | NA | 12,240 | 88,000 | NA | 12,760 | 241,000 | NA | 25,000 |
| 1987 | 127,000 | NA | 10,160 | 59,000 | NA | 8,555 | 186,000 | NA | 18,715 |
| 1988 | 133,000 | NA | 10,640 | 63,000 | NA | 9,135 | 196,000 | NA | 19,775 |
| 1989 | 156,000 | NA | 12,480 | 75,000 | NA | 10,875 | 231,000 | NA | 23,355 |
| 1990 | 179,593 | NA | 14,367 | 71,000 | NA | 10,295 | 250,593 | NA | 24,662 |
| 1991 | 89,495 | NA | 7,160 | 48,859 | NA | 7,085 | 138,354 | NA | 14,244 |
| 1992 | 63,460 | NA | 5,077 | 51,656 | NA | 7,490 | 115,116 | NA | 12,567 |
| 1993 | 54,968 | NA | 4,397 | 41,034 | NA | 5,950 | 96,002 | NA | 10,347 |
| 1994 | 63,577 | NA | 5,086 | 44,181 | NA | 6,406 | 107,758 | NA | 11,492 |
| 1995 | 63,593 | NA | 5,087 | 61,509 | NA | 8,919 | 125,102 | NA | 14,006 |
| 1996 | 61,658 | NA | 4,933 | 58,538 | NA | 8,488 | 120,196 | NA | 13,421 |

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Appendix A.18.–Page 2 of 2.

| Year | Washington – Other Puget Sound | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Net | | | Sport | | | Total | | |
| | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM |
| 1997 | 47,522 | NA | 3,802 | 43,961 | NA | 6,374 | 91,483 | NA | 10,176 |
| 1998 | 50,915 | NA | 4,073 | 30,016 | NA | 4,352 | 80,931 | NA | 8,426 |
| 1999 | 91,947 | NA | 7,356 | 34,116 | NA | 4,947 | 126,063 | NA | 12,303 |
| 2000 | 79,494 | NA | 6,360 | 29,328 | NA | 4,253 | 108,822 | NA | 10,612 |
| 2001 | 123,266 | NA | 9,861 | 40,170 | NA | 5,825 | 163,436 | NA | 15,686 |
| 2002 | 108,566 | NA | 8,685 | 35,031 | NA | 5,079 | 143,597 | NA | 13,765 |
| 2003 | 86,206 | NA | 6,896 | 32,210 | 93,129 | 29,629 | 118,416 | 93,129 | 36,526 |
| 2004 | 69,211 | NA | 5,537 | 22,650 | 64,586 | 20,593 | 91,861 | 64,586 | 26,130 |
| 2005 | 82,629 | 557 | 7,156 | 30,760 | 50,748 | 18,061 | 108,638 | 51,306 | 25,217 |
| 2006 | 109,557 | NA | 8,765 | 40,082 | 152,129 | 46,582 | 149,639 | 152,129 | 55,347 |
| 2007 | 118,628 | NA | 9,490 | 57,468 | 149,778 | 48,473 | 176,096 | 149,778 | 57,964 |
| 2008 | 101,322 | NA | 8,106 | 36,969 | 86,174 | 28,455 | 138,291 | 86,174 | 36,561 |
| 2009 | 68,764 | NA | 5,501 | 33,332 | 75,820 | 25,153 | 102,096 | 75,820 | 30,654 |
| 2010 | 72,576 | NA | 5,806 | 32,817 | 43,512 | 16,420 | 105,393 | 43,512 | 22,226 |
| 2011 | 100,692 | NA | 8,055 | 29,829 | 78,760 | 25,433 | 130,521 | 78,760 | 33,488 |
| 2012 | 115,917 | NA | 9,273 | 31,993[1] | 66,031[1] | 22,335[1] | 147,910 | 66,031 | 31,608 |

*Note*: Net = Areas 6B, 6D, 7B, 7C, and 7E, Areas 8–13 (including all sub-areas), and Areas 74C–83F; Sport = Areas 8–13 and all Puget Sound Rivers.

*Note*: NA = not available. For fisheries without estimate of releases, IM is dropoff/dropout only.

[1] Current year not available; values are average of previous three years.

Appendix A.19.–Washington– Inside Coastal ISBM Chinook salmon landed catch (LC), releases (Rel.), and incidental mortality (IM).

| | Washington – Inside Coastal | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Net | | | Sport | | | Total | | |
| Year | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM |
| 1975 | 34,859 | NA | 697 | 1,716 | NA | 118 | 36,575 | NA | 816 |
| 1976 | 51,995 | NA | 1,040 | 2,219 | NA | 153 | 54,214 | NA | 1,193 |
| 1977 | 72,467 | NA | 1,449 | 2,043 | NA | 141 | 74,510 | NA | 1,590 |
| 1978 | 32,662 | NA | 653 | 3,399 | NA | 235 | 36,061 | NA | 888 |
| 1979 | 36,501 | NA | 730 | 2,199 | NA | 152 | 38,700 | NA | 882 |
| 1980 | 47,681 | NA | 954 | 1,476 | NA | 102 | 49,157 | NA | 1,055 |
| 1981 | 36,880 | NA | 738 | 786 | NA | 54 | 37,666 | NA | 792 |
| 1982 | 33,271 | NA | 665 | 1,114 | NA | 77 | 34,385 | NA | 742 |
| 1983 | 16,210 | NA | 324 | 1,452 | NA | 100 | 17,662 | NA | 424 |
| 1984 | 16,239 | NA | 325 | 1,319 | NA | 91 | 17,558 | NA | 416 |
| 1985 | 25,162 | NA | 503 | 1,955 | NA | 135 | 27,117 | NA | 638 |
| 1986 | 29,000 | NA | 580 | 3,000 | NA | 207 | 32,000 | NA | 787 |
| 1987 | 51,000 | NA | 1,020 | 3,000 | NA | 207 | 54,000 | NA | 1,227 |
| 1988 | 74,000 | NA | 1,480 | 7,000 | NA | 483 | 81,000 | NA | 1,963 |
| 1989 | 85,000 | NA | 1,700 | 6,000 | NA | 414 | 91,000 | NA | 2,114 |
| 1990 | 57,770 | NA | 1,155 | 5,000 | NA | 345 | 62,770 | NA | 1,500 |
| 1991 | 54,397 | NA | 1,088 | 6,070 | NA | 419 | 60,467 | NA | 1,507 |
| 1992 | 64,223 | NA | 1,284 | 6,577 | NA | 454 | 70,800 | NA | 1,738 |
| 1993 | 59,285 | NA | 1,186 | 9,180 | NA | 633 | 68,465 | NA | 1,819 |
| 1994 | 46,059 | NA | 921 | 7,454 | NA | 514 | 53,513 | NA | 1,436 |
| 1995 | 46,490 | NA | 930 | 9,881 | NA | 682 | 56,371 | NA | 1,612 |
| 1996 | 55,408 | NA | 1,108 | 12,059 | NA | 832 | 67,467 | NA | 1,940 |
| 1997 | 28,269 | NA | 565 | 6,619 | NA | 457 | 34,888 | NA | 1,022 |
| 1998 | 20,266 | NA | 405 | 6,569 | NA | 453 | 26,835 | NA | 859 |
| 1999 | 11,400 | NA | 228 | 3,165 | NA | 218 | 14,565 | NA | 446 |
| 2000 | 15,660 | NA | 313 | 3,179 | NA | 219 | 18,839 | NA | 533 |
| 2001 | 19,480 | NA | 390 | 8,645 | NA | 597 | 28,125 | NA | 986 |
| 2002 | 23,372 | NA | 467 | 6,038 | NA | 417 | 29,410 | NA | 884 |
| 2003 | 18,443 | NA | 369 | 6,075 | NA | 419 | 24,518 | NA | 788 |
| 2004 | 21,965 | NA | 439 | 12,088 | NA | 834 | 34,053 | NA | 1,273 |
| 2005 | 20,668 | NA | 413 | 7,051 | NA | 487 | 27,719 | NA | 900 |
| 2006 | 27,414 | NA | 548 | 8,030 | NA | 554 | 35,444 | NA | 1,102 |
| 2007 | 12,353 | NA | 247 | 5,066 | NA | 350 | 17,419 | NA | 597 |

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| Year | Washington – Inside Coastal | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Net | | | Sport | | | Total | | |
| | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM |
| 2008 | 15,028 | NA | 301 | 3,808 | NA | 263 | 18,836 | NA | 563 |
| 2009 | 18,728 | NA | 375 | 6,629 | NA | 457 | 25,357 | NA | 832 |
| 2010 | 12,794 | NA | 256 | 6,831 | NA | 471 | 19,625 | NA | 727 |
| 2011 | 39,034 | NA | 781 | 13,340 | NA | 920 | 52,374 | NA | 1,701 |
| 2012 | 29,232 | NA | 585 | 8,933[1] | NA | 616[1] | 38,165 | NA | 1,201 |

*Note*: Net = Areas 2A–2M;, and Areas 72B–73H; Sport = All coastal rivers, Area 2.1, and Area 2.2 (when Area 2 is closed)

*Note*: NA = not available. For fisheries without estimate of releases, IM is dropoff/dropout only.

[1] Current year not available; values are average of previous three years.

Appendix A.20.–Washington/Oregon North of Cape Falcon ISBM Chinook salmon landed catch (LC), releases (Rel.), and incidental mortality (IM).

| | Washington/Oregon North of Cape Falcon | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Troll | | | Net | | | Sport | | | Total | | |
| Year | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM |
| 1975 | 268,971 | NA | 6,724 | 1,212 | NA | 24 | 265,785 | NA | 7,176 | 535,968 | NA | 13,925 |
| 1976 | 371,239 | NA | 9,281 | 203 | NA | 4 | 215,319 | NA | 5,814 | 586,761 | NA | 15,099 |
| 1977 | 244,491 | NA | 6,112 | 4 | NA | 0 | 197,563 | NA | 5,334 | 442,058 | NA | 11,447 |
| 1978 | 150,673 | NA | 3,767 | 4 | NA | 0 | 104,306 | NA | 2,816 | 254,983 | NA | 6,583 |
| 1979 | 133,035 | NA | 3,326 | 3 | NA | 0 | 84,977 | NA | 2,294 | 218,015 | NA | 5,620 |
| 1980 | 125,709 | NA | 3,143 | 1,215 | NA | 24 | 59,099 | NA | 1,596 | 186,023 | NA | 4,763 |
| 1981 | 109,519 | NA | 2,738 | 209 | NA | 4 | 96,151 | NA | 2,596 | 205,879 | NA | 5,338 |
| 1982 | 154,720 | NA | 3,868 | 267 | NA | 5 | 114,952 | NA | 3,104 | 269,939 | NA | 6,977 |
| 1983 | 63,584 | NA | 1,590 | 62 | NA | 1 | 51,789 | NA | 1,398 | 115,435 | NA | 2,989 |
| 1984 | 15,392 | NA | 385 | 0 | NA | 0 | 6,980 | NA | 188 | 22,372 | NA | 573 |
| 1985 | 55,408 | NA | 1,385 | 493 | NA | 10 | 30,189 | NA | 815 | 86,090 | NA | 2,210 |
| 1986 | 52,000 | NA | 1,300 | 0 | NA | 0 | 23,000 | NA | 621 | 75,000 | NA | 1,921 |
| 1987 | 81,000 | NA | 2,025 | 4,000 | NA | 80 | 44,000 | NA | 1,188 | 129,000 | NA | 3,293 |
| 1988 | 108,000 | NA | 2,700 | 3,000 | NA | 60 | 19,000 | NA | 513 | 130,000 | NA | 3,273 |
| 1989 | 74,600 | NA | 1,865 | 1,000 | NA | 20 | 20,900 | NA | 564 | 96,500 | NA | 2,449 |
| 1990 | 65,800 | NA | 1,645 | 0 | 0 | 0 | 32,900 | NA | 888 | 98,700 | NA | 2,533 |
| 1991 | 51,600 | NA | 1,290 | 0 | 0 | 0 | 13,300 | NA | 359 | 64,900 | NA | 1,649 |
| 1992 | 69,000 | NA | 1,725 | 0 | 0 | 0 | 18,900 | NA | 510 | 87,900 | NA | 2,235 |
| 1993 | 55,900 | NA | 1,398 | 0 | 0 | 0 | 13,600 | NA | 367 | 69,500 | NA | 1,765 |
| 1994 | 4,500 | NA | 113 | 0 | 0 | 0 | 0 | NA | – | 4,500 | NA | 113 |
| 1995 | 9,500 | NA | 238 | 0 | 0 | 0 | 600 | NA | 16 | 10,100 | NA | 254 |
| 1996 | 12,300 | NA | 308 | 0 | 0 | 0 | 200 | NA | 5 | 12,500 | NA | 313 |

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Appendix A.20.–Page 2 of 2.

| | Washington/Oregon North of Cape Falcon | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Troll | | | Net | | | Sport | | | Total | | |
| Year | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM |
| 1997 | 20,500 | NA | 513 | 0 | 0 | 0 | 4,100 | NA | 111 | 24,600 | NA | 623 |
| 1998 | 20,615 | 12,496 | 3,577 | 0 | 0 | 0 | 2,292 | 2,729 | 471 | 22,907 | 15,225 | 4,048 |
| 1999 | 44,923 | 27,231 | 7,795 | 0 | 0 | 0 | 10,821 | 6,782 | 1,309 | 55,744 | 34,013 | 9,104 |
| 2000 | 20,152 | 12,215 | 3,497 | 0 | 0 | 0 | 9,242 | 8,433 | 1,515 | 29,394 | 20,649 | 5,011 |
| 2001 | 54,163 | 35,824 | 10,131 | 0 | 0 | 0 | 25,592 | 34,500 | 5,866 | 79,755 | 70,324 | 15,997 |
| 2002 | 106,462 | 60,250 | 17,423 | 0 | 0 | 0 | 60,575 | 74,008 | 12,737 | 167,037 | 134,257 | 30,159 |
| 2003 | 101,758 | 54,313 | 15,851 | 0 | 0 | 0 | 36,513 | 50,214 | 8,518 | 138,271 | 104,526 | 24,368 |
| 2004 | 88,225 | 83,219 | 22,594 | 0 | 0 | 0 | 27,090 | 74,410 | 11,893 | 115,315 | 157,629 | 34,487 |
| 2005 | 87,126 | 36,282 | 11,067 | 0 | 0 | 0 | 40,004 | 22,798 | 4,500 | 127,130 | 59,080 | 15,567 |
| 2006 | 57,313 | 52,482 | 14,291 | 0 | 0 | 0 | 11,176 | 10,309 | 1,848 | 68,489 | 62,791 | 16,139 |
| 2007 | 38,742 | 36,050 | 9,801 | 0 | 0 | 0 | 9,535 | 22,629 | 3,652 | 48,277 | 58,678 | 13,452 |
| 2008 | 35,100 | NA | 878 | 0 | 0 | 0 | 15,452 | 7,400 | 1,527 | 50,552 | 7,400 | 2,405 |
| 2009 | 25,410 | NA | 635 | 0 | 0 | 0 | 13,331 | 38,717 | 6,168 | 38,741 | 38,717 | 6,803 |
| 2010 | 88,565 | NA | 2,214 | 0 | 0 | 0 | 38,686 | 36,403 | 6,505 | 127,251 | 36,403 | 8,719 |
| 2011 | 61,433 | NA | 1,536 | 0 | 0 | 0 | 30,826 | 55,050 | 9,090 | 92,259 | 55,050 | 10,626 |
| 2012 | 99,792 | NA | 2,495 | 0 | 0 | 0 | 35,428[1] | 42,874[1] | 7,388[1] | 135,220 | 42,874 | 9,882 |

*Note*: Troll = Oregon Area 2; Washington Areas 1, 2, 3 and 4: Area 4B from May 1 through September 30 (during Pacific Fishery Management Council management); Net = Washington Areas 1, 2, 3, 4, 4A; Sport = Oregon Area 2; Washington Areas 1, 1.1, 1.2, 2, 3, 4 and 2.2 (when Area 2 is open).

*Note*: For fisheries without estimate of releases, IM is dropoff/dropout only.

[1] Current year not available; values are average of previous three years.

Appendix A.21.–Columbia River ISBM Chinook salmon landed catch (LC), releases (Rel.), and incidental mortality (IM).

| | Washington and Oregon Columbia River[1] | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Non-treaty Net | | | Treaty Indian Net | | | Sport | | | Total | | |
| Year | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM |
| 1975[2] | 323,000 | 0 | 9,690 | | | | 34,870 | NA | 2,406 | 357,870 | NA | 12,096 |
| 1976[2] | 288,400 | 0 | 8,652 | | | | 42,527 | NA | 2,934 | 330,927 | NA | 11,586 |
| 1977[2] | 255,600 | 0 | 7,668 | | | | 58,838 | NA | 4,060 | 314,438 | NA | 11,728 |
| 1978[2] | 189,100 | 0 | 5,673 | | | | 56,582 | NA | 3,904 | 245,682 | NA | 9,577 |
| 1979[2] | 169,691 | 0 | 5,091 | 7,865 | 0 | 236 | 38,700 | NA | 2,670 | 216,256 | NA | 7,997 |
| 1980 | 113,569 | 0 | 3,407 | 35,604 | 0 | 1,068 | 15,011 | NA | 1,036 | 164,184 | NA | 5,511 |
| 1981 | 35,881 | 0 | 1,076 | 54,190 | 0 | 1,626 | 21,151 | NA | 1,459 | 111,222 | NA | 4,162 |
| 1982 | 94,289 | 0 | 2,829 | 67,224 | 0 | 2,017 | 31,236 | NA | 2,155 | 192,749 | NA | 7,001 |
| 1983 | 32,877 | 0 | 986 | 34,036 | 0 | 1,021 | 23,206 | NA | 1,601 | 90,119 | NA | 3,609 |
| 1984 | 73,481 | 0 | 2,204 | 61,828 | 0 | 1,855 | 43,760 | NA | 3,019 | 179,069 | NA | 7,079 |
| 1985 | 74,982 | 0 | 2,249 | 80,436 | 0 | 2,413 | 45,444 | NA | 3,136 | 200,862 | NA | 7,798 |
| 1986 | 168,038 | 0 | 5,041 | 118,578 | 0 | 3,557 | 57,993 | NA | 4,002 | 344,609 | NA | 12,600 |
| 1987 | 340,931 | 0 | 10,228 | 154,169 | 0 | 4,625 | 105,835 | NA | 7,303 | 600,935 | NA | 22,156 |
| 1988 | 341,114 | 0 | 10,233 | 165,677 | 0 | 4,970 | 97,638 | NA | 6,737 | 604,429 | NA | 21,941 |
| 1989 | 146,739 | 0 | 4,402 | 145,859 | 0 | 4,376 | 88,088 | NA | 6,078 | 380,686 | NA | 14,856 |
| 1990 | 63,602 | 0 | 1,908 | 95,317 | 0 | 2,860 | 79,467 | NA | 5,483 | 238,386 | NA | 10,251 |
| 1991 | 53,935 | 0 | 1,618 | 60,931 | 0 | 1,828 | 79,260 | NA | 5,469 | 194,126 | NA | 8,915 |
| 1992 | 24,063 | 0 | 722 | 39,616 | 0 | 1,188 | 56,417 | NA | 3,893 | 120,096 | NA | 5,803 |
| 1993 | 19,929 | 0 | 598 | 51,516 | 0 | 1,545 | 64,995 | NA | 4,485 | 136,440 | NA | 6,628 |
| 1994 | 2,773 | 0 | 83 | 36,633 | 0 | 1,099 | 29,634 | NA | 2,045 | 69,040 | NA | 3,227 |
| 1995 | 777 | 0 | 23 | 43,010 | 0 | 1,290 | 36,394 | NA | 2,511 | 80,181 | NA | 3,825 |
| 1996 | 17,774 | 0 | 533 | 70,956 | 0 | 2,129 | 31,672 | NA | 2,185 | 120,402 | NA | 4,847 |

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Appendix A.21.–Page 2 of 2.

| Year | Washington and Oregon Columbia River[1] | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Non-treaty Net | | | Treaty Indian Net | | | Sport | | | Total | | |
| | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM |
| 1997 | 11,268 | 0 | 338 | 76,473 | 0 | 2,294 | 45,984 | NA | 3,173 | 133,725 | NA | 5,805 |
| 1998 | 6,409 | 0 | 192 | 48,410 | 0 | 1,452 | 34,342 | NA | 2,370 | 89,161 | NA | 4,014 |
| 1999 | 10,090 | NA | 303 | 81,164 | 0 | 2,435 | 45,094 | NA | 3,111 | 136,348 | NA | 5,849 |
| 2000 | 21,318 | NA | 640 | 70,848 | 0 | 2,125 | 49,150 | NA | 3,391 | 141,316 | NA | 6,156 |
| 2001 | 42,570 | 3,050 | 7,663 | 184,393 | 0 | 5,532 | 138,360 | 61,882 | 21,428 | 365,323 | 64,933 | 34,623 |
| 2002 | 70,386 | 28,160 | 15,439 | 181,413 | 0 | 5,442 | 147,146 | 61,769 | 22,013 | 398,945 | 89,929 | 42,894 |
| 2003 | 76,030 | 9,271 | 9,597 | 157,329 | 0 | 4,720 | 145,794 | 44,122 | 18,531 | 379,153 | 53,393 | 32,848 |
| 2004 | 77,443 | 9,205 | 9,726 | 160,855 | 0 | 4,826 | 145,916 | 32,757 | 16,358 | 384,214 | 41,962 | 30,909 |
| 2005 | 45,856 | 2,540 | 6,093 | 133,533 | 0 | 4,006 | 89,933 | 39,043 | 13,702 | 269,322 | 41,583 | 23,801 |
| 2006 | 44,478 | 6,098 | 6,323 | 109,384 | 0 | 3,282 | 70,990 | 12,235 | 7,247 | 224,852 | 18,333 | 16,852 |
| 2007 | 26,767 | 2,560 | 3,334 | 60,485 | 0 | 1,815 | 54,613 | 10,060 | 5,700 | 141,865 | 12,620 | 10,849 |
| 2008 | 51,988 | 2,810 | 6,656 | 143,641 | 0 | 4,309 | 87,118 | 14,019 | 8,703 | 282,747 | 16,829 | 19,668 |
| 2009 | 54,913 | 3,073 | 5,823 | 110,079 | 0 | 3,302 | 88,783 | 14,422 | 8,895 | 253,775 | 17,496 | 18,021 |
| 2010 | 89,129 | 7,826 | 10,947 | 202,288 | 0 | 6,069 | 162,707 | 24,187 | 15,871 | 454,124 | 32,013 | 32,886 |
| 2011 | 92,082 | 6,964 | 9,928 | 173,658 | 0 | 5,210 | 149,907 | 27,161 | 15,558 | 415,647 | 34,125 | 30,696 |
| 2012 | 76,315 | 4,436 | 8,608 | 168,825 | 0 | 5,065 | 122,411 | 28,719 | 13,960 | 367,551 | 33,155 | 27,633 |

[1] The historical time series of catches in this year's report has changed from previous year's report. Catches after 1980 have been broken out into non-treaty net and treaty Indian due to the inability to separate Treaty Indian commercial versus non-commercial. Non-treaty net includes catches by Wanapum and Colville tribes. Sport and total catches from 1975 to 1980 are consistent with previous year's reports.

[2] The Treaty Indian Net catch estimates from 1975 to 1979 are not available, but are believed to be of the magnitude seen after 1979; the catch for 1979 represents spring run catches and does not include catch estimates for summer and fall stocks. Sport and total catch estimates from 1975 to 1979 are consistent with previous year's reports, but the total is underestimated because of the missing estimates.

Appendix A.22.–Oregon ISBM Chinook salmon landed catch (LC), releases (Rel.), and incidental mortality (IM).

| | Oregon Coastal Inside | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Troll | | | Sport | | | Total | | |
| Year | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM |
| 1975 | 300 | NA | 5 | 19,000 | NA | 1,311 | 19,300 | NA | 1,316 |
| 1976 | 1,000 | NA | 17 | 21,000 | NA | 1,449 | 22,000 | NA | 1,466 |
| 1977 | 3,000 | NA | 51 | 34,000 | NA | 2,346 | 37,000 | NA | 2,397 |
| 1978 | 1,000 | NA | 17 | 37,000 | NA | 2,553 | 38,000 | NA | 2,570 |
| 1979 | 800 | NA | 14 | 31,000 | NA | 2,139 | 31,800 | NA | 2,153 |
| 1980 | 300 | NA | 5 | 22,000 | NA | 1,518 | 22,300 | NA | 1,523 |
| 1981 | 300 | NA | 5 | 28,000 | NA | 1,932 | 28,300 | NA | 1,937 |
| 1982 | 500 | NA | 9 | 23,000 | NA | 1,587 | 23,500 | NA | 1,596 |
| 1983 | 700 | NA | 12 | 19,000 | NA | 1,311 | 19,700 | NA | 1,323 |
| 1984 | 1,088 | NA | 17 | 27,000 | NA | 1,863 | 28,088 | NA | 1,880 |
| 1985 | 1,700 | NA | 27 | 25,000 | NA | 1,725 | 26,700 | NA | 1,752 |
| 1986 | 1,900 | NA | 30 | 33,000 | NA | 2,277 | 34,900 | NA | 2,307 |
| 1987 | 3,600 | NA | 58 | 46,000 | NA | 3,174 | 49,600 | NA | 3,232 |
| 1988 | 4,800 | NA | 77 | 49,000 | NA | 3,381 | 53,800 | NA | 3,458 |
| 1989 | 4,500 | NA | 72 | 45,000 | NA | 3,105 | 49,500 | NA | 3,177 |
| 1990 | 0 | NA | 0 | 38,000 | NA | 2,622 | 38,000 | NA | 2,622 |
| 1991 | 0 | NA | 0 | 44,500 | NA | 3,071 | 44,500 | NA | 3,071 |
| 1992 | 384 | NA | 6 | 39,000 | NA | 2,691 | 39,384 | NA | 2,697 |
| 1993 | 649 | NA | 10 | 52,000 | NA | 3,588 | 52,649 | NA | 3,598 |
| 1994 | 371 | NA | 6 | 33,590 | NA | 2,318 | 33,961 | NA | 2,324 |
| 1995 | 206 | NA | 3 | 48,366 | NA | 3,337 | 48,572 | NA | 3,341 |
| 1996 | 989 | NA | 16 | 56,202 | NA | 3,878 | 57,191 | NA | 3,894 |
| 1997 | 513 | NA | 8 | 37,659 | NA | 2,598 | 38,172 | NA | 2,607 |
| 1998 | 858 | NA | 14 | 37,990 | NA | 2,621 | 38,848 | NA | 2,635 |
| 1999 | 1,233 | NA | 20 | 30,735 | NA | 2,121 | 31,968 | NA | 2,140 |
| 2000 | 1,860 | NA | 30 | 33,262 | NA | 2,295 | 35,122 | NA | 2,325 |
| 2001 | 1,184 | NA | 19 | 54,988 | NA | 3,794 | 56,172 | NA | 3,813 |
| 2002 | 1,633 | NA | 26 | 61,085 | NA | 4,215 | 62,718 | NA | 4,241 |
| 2003 | 1,459 | NA | 23 | 67,939 | NA | 4,688 | 69,398 | NA | 4,711 |
| 2004 | 2,258 | NA | 36 | 71,726 | NA | 4,949 | 73,984 | NA | 4,985 |
| 2005 | 1,956 | NA | 31 | 27,866 | NA | 1,923 | 29,822 | NA | 1,954 |

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| | Oregon Coastal Inside | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Troll | | | Sport | | | Total | | |
| Year | LC | Rel. | IM | LC | Rel. | IM | LC | Rel. | IM |
| 2006 | 1,884 | NA | 30 | 39,357 | NA | 2,716 | 41,241 | NA | 2,746 |
| 2007 | 1,018 | NA | 16 | 25,684 | NA | 1,772 | 26,702 | NA | 1,788 |
| 2008 | 208 | NA | 3 | 10,780 | NA | 744 | 10,988 | NA | 747 |
| 2009 | 293 | NA | 5 | 6,537 | NA | 451 | 6,830 | NA | 456 |
| 2010 | 1,315 | NA | 21 | 23,366 | NA | 1,612 | 24,681 | NA | 1,633 |
| 2011 | 1,954 | NA | 31 | 33,089 | NA | 2,283 | 35,043 | NA | 2,314 |
| 2012 | 636 | NA | 10 | 26,485[1] | NA | 1,827[1] | 27,121 | NA | 1,837 |

*Note*: Troll = late season off Elk River mouth, Sport = estuary and inland.

*Note*: NA = not available.

[1] Preliminary value based on average harvest rates.

Appendix A.23.–Summary of landed catches of PSC AABM and ISBM fisheries.

| Year[1] | Southeast Alaska AABM [2,3] | Southeast Alaska Non-Treaty | U.S. ISBM[4] | U.S. Total | NBC AABM[2] | WCVI AABM[2] | Canada ISBM[4,5] | Canada Total | PSC Total |
|---|---|---|---|---|---|---|---|---|---|
| 1975 | 317,707 | | 1,114,483 | 1,114,483 | 228,121 | 546,214 | 949,027 | 1,723,362 | 2,837,845 |
| 1976 | 258,762 | | 1,148,707 | 1,148,707 | 190,267 | 665,010 | 1,078,748 | 1,934,025 | 3,082,732 |
| 1977 | 302,178 | | 972,309 | 972,309 | 131,005 | 545,742 | 1,070,562 | 1,747,309 | 2,719,618 |
| 1978 | 418,411 | | 782,501 | 782,501 | 146,179 | 568,705 | 1,078,144 | 1,793,028 | 2,575,529 |
| 1979 | 382,641 | | 729,949 | 729,949 | 147,576 | 477,222 | 991,275 | 1,616,073 | 2,346,022 |
| 1980 | 343,970 | | 890,965 | 890,965 | 157,398 | 486,303 | 834,970 | 1,478,671 | 2,369,636 |
| 1981 | 289,034 | | 780,224 | 780,224 | 153,249 | 423,266 | 753,274 | 1,329,789 | 2,110,013 |
| 1982 | 314,686 | | 872,679 | 872,679 | 173,687 | 538,510 | 675,615 | 1,387,812 | 2,260,491 |
| 1983 | 311,658 | | 637,515 | 637,515 | 162,927 | 395,636 | 643,798 | 1,202,361 | 1,839,876 |
| 1984 | 290,077 | | 665,122 | 665,122 | 185,305 | 471,294 | 797,637 | 1,454,236 | 2,119,358 |
| 1985 | 268,293 | 6,246 | 734,199 | 1,008,738 | 166,445 | 345,937 | 560,334 | 1,072,716 | 2,081,454 |
| 1986 | 271,262 | 11,091 | 879,509 | 1,161,862 | 176,868 | 350,227 | 507,713 | 1,034,808 | 2,196,670 |
| 1987 | 265,323 | 17,095 | 1,171,535 | 1,453,953 | 180,101 | 378,931 | 403,783 | 962,815 | 2,416,768 |
| 1988 | 256,787 | 22,525 | 1,204,229 | 1,483,541 | 159,428 | 408,668 | 379,588 | 947,684 | 2,431,225 |
| 1989 | 269,522 | 21,510 | 1,001,686 | 1,292,718 | 228,331 | 203,751 | 486,957 | 919,039 | 2,211,757 |
| 1990 | 320,996 | 45,873 | 808,452 | 1,175,321 | 170,936 | 297,858 | 469,730 | 938,524 | 2,113,845 |
| 1991 | 297,986 | 61,476 | 599,534 | 958,996 | 209,065 | 203,035 | 558,591 | 970,691 | 1,929,687 |
| 1992 | 221,980 | 36,811 | 525,084 | 783,875 | 163,698 | 358,664 | 457,906 | 980,268 | 1,764,143 |
| 1993 | 271,193 | 32,910 | 487,927 | 792,030 | 186,983 | 300,345 | 460,360 | 947,688 | 1,739,718 |
| 1994 | 235,165 | 29,185 | 299,419 | 563,769 | 193,554 | 160,352 | 303,807 | 657,713 | 1,221,482 |
| 1995 | 176,939 | 58,800 | 351,046 | 586,785 | 79,388 | 95,410 | 205,308 | 380,106 | 966,891 |
| 1996 | 154,997 | 81,262 | 409,703 | 645,962 | 678 | 10,233 | 220,570 | 231,481 | 877,443 |

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Appendix A.23.–Page 2 of 2.

| Year[1] | Southeast Alaska AABM [2,3] | Southeast Alaska Non-Treaty | U.S. ISBM[4] | U.S. Total | NBC AABM[2] | WCVI AABM[2] | Canada ISBM[4,5] | Canada Total | PSC Total |
|---|---|---|---|---|---|---|---|---|---|
| 1997 | 286,696 | 56,306 | 375,204 | 718,206 | 110,999 | 59,088 | 263,346 | 433,433 | 1,151,639 |
| 1998 | 243,152 | 27,441 | 268,693 | 539,286 | 143,202 | 9,317 | 196,352 | 348,871 | 888,157 |
| 1999 | 198,842 | 52,178 | 371,349 | 622,369 | 84,324 | 38,540 | 223,695 | 346,559 | 968,928 |
| 2000 | 186,493 | 76,797 | 341,695 | 604,985 | 32,048 | 88,617 | 168,926 | 289,591 | 894,576 |
| 2001 | 186,919 | 78,815 | 708,027 | 973,761 | 43,334 | 120,304 | 208,302 | 371,940 | 1,345,701 |
| 2002 | 357,133 | 69,401 | 813,652 | 1,240,186 | 149,961 | 157,886 | 239,111 | 546,958 | 1,787,144 |
| 2003 | 380,152 | 59,284 | 744,225 | 1,183,661 | 195,352 | 173,561 | 252,260 | 621,173 | 1,804,834 |
| 2004 | 417,019 | 82,249 | 732,443 | 1,231,711 | 243,806 | 215,252 | 292,646 | 751,704 | 1,983,415 |
| 2005 | 390,336 | 102,781 | 577,911 | 1,071,028 | 244,581 | 199,479 | 283,736 | 727,796 | 1,798,824 |
| 2006 | 361,283 | 74,222 | 536,878 | 972,383 | 215,993 | 145,485 | 274,179 | 635,657 | 1,608,040 |
| 2007 | 327,989 | 76,649 | 429,338 | 833,976 | 144,339 | 140,614 | 234,538 | 519,491 | 1,353,467 |
| 2008 | 171,983 | 72,247 | 518,530 | 762,760 | 95,647 | 145,726 | 185,482 | 426,855 | 1,189,615 |
| 2009 | 227,667 | 66,007 | 446,436 | 740,110 | 109,640 | 124,617 | 206,075 | 440,332 | 1,180,442 |
| 2010 | 229,355 | 55,225 | 755,039 | 1,039,619 | 136,614 | 139,047 | 165,104 | 440,765 | 1,480,384 |
| 2011 | 292,028 | 64,960 | 751,793 | 1,108,781 | 122,660 | 204,232 | 280,029 | 606,921 | 1,715,702 |
| 2012 | 241,015 | 54,380 | 734,159 | 1,029,554 | 120,307 | 134,468 | 189,820 | 444,595 | 1,474,149 |

[1] All landed catches from 1975 to 1984 were taken prior to implementation of the PST.

[2] LC in AABM fisheries from 1985 to 1994 were taken under fixed ceiling management per the 1985 PST Agreement. Catches from 1995 to 1998 were between agreements. LC from 1999 to 2012 was taken commensurate with abundance-based management per the 1999 PST Agreement (1999–2008) and the 2009 PST Agreement (2009–present).

[3] Southeast Alaska non-treaty catches are primarily Alaska hatchery add-ons, but include terminal exclusions is some years from terminal catches from the Situk, Taku and Stikine rivers.

[4] U.S. and Canadian ISBM fisheries had a pass-through obligation from 1985 to 1994 under the 1985 PST Agreement and have operated with the ISBM index obligations since 1999, under the 1999 and 2009 Agreements

[5] Catches in the Canada ISBM column include catches in the Strait of Georgia (troll and sport), Central British Columbia troll, and Northern British Columbia net and mainland sport fisheries from 1985 to 1994 when these were AABM fisheries operating under fixed ceiling management provisions of the 1985 PST Agreement.

Appendix A.24.–Estimated incidental mortality (LIM and SIM in nominal fish) associated with Chinook salmon catches in U.S. and Canadian AABM and ISBM fisheries.

| Year[1] | Southeast Alaska AABM[2] | Southeast Alaska Non-Treaty | U.S. ISBM | U.S. Total | NBC AABM[2] | WCVI AABM[2] | Can ISBM[3] | Can Total | PSC Total[4] |
|---|---|---|---|---|---|---|---|---|---|
| 2005 | 46,016 | 10,482 | 72,256 | 128,754 | 21,701 | 14,814 | 45,526 | 82,041 | 210,794 |
| 2006 | 48,000 | 8,600 | 98,809 | 155,409 | 13,360 | 11,557 | 34,013 | 58,930 | 214,339 |
| 2007 | 70,719 | 23,001 | 94,340 | 188,060 | 13,003 | 12,403 | 39,884 | 65,290 | 253,349 |
| 2008 | 38,127 | 8,641 | 66,264 | 113,032 | 5,764 | 12,312 | 23,914 | 41,990 | 155,022 |
| 2009 | 44,893 | 11,123 | 74,537 | 130,553 | 8,913 | 15,817 | 37,783 | 62,512 | 193,065 |
| 2010 | 38,353 | 5,592 | 83,767 | 127,712 | 11,056 | 16,017 | 24,638 | 51,712 | 179,424 |
| 2011 | 41,700 | 9,782 | 98,502 | 149,983 | 18,619 | 17,005 | 31,400 | 67,024 | 217,007 |
| 2012 | 45,608 | 20,762 | 85,360 | 151,729 | 11,475 | 16,390 | 32,287 | 60,151 | 211,881 |

[1] The IM estimates presented in this table are not equivalent to LC on a one-to-one fish basis because of the inclusion of SIMs, which are smaller, less mature fish.

[2] IM estimates (LIM + SIM) are available for AABM fisheries from 1985 to present (CTC 2011).

[3] IM estimates for the ISBM fisheries prior to 2005 were not available for many sub-components of these fisheries at this printing, but will be included in next year's CTC catch and escapement report.

[4] The PST total needs to be viewed with caution per footnote 1.

Appendix A.25.–Estimated total mortality (LC and IM) associated with Chinook salmon catches in U.S. and Canadian AABM and ISBM fisheries.

| Year | Southeast Alaska AABM | Southeast Alaska Non-Treaty | U.S. ISBM | U.S. Total | NBC AABM | WCVI AABM | Can ISBM | Can Total | PSC Total[1] |
|---|---|---|---|---|---|---|---|---|---|
| 2005 | 436,352 | 113,263 | 650,167 | 1,199,782 | 266,282 | 214,293 | 329,262 | 809,837 | 2,009,618 |
| 2006 | 409,283 | 82,822 | 635,687 | 1,127,792 | 229,353 | 157,042 | 308,192 | 694,587 | 1,822,379 |
| 2007 | 398,708 | 99,650 | 523,678 | 1,022,036 | 157,342 | 153,017 | 274,422 | 584,781 | 1,606,816 |
| 2008 | 210,110 | 80,888 | 584,794 | 875,792 | 101,411 | 158,038 | 209,395 | 468,844 | 1,344,636 |
| 2009 | 272,560 | 77,130 | 520,973 | 870,663 | 118,553 | 140,434 | 243,858 | 502,844 | 1,373,507 |
| 2010 | 267,708 | 60,817 | 838,806 | 1,167,331 | 147,670 | 155,064 | 189,742 | 492,477 | 1,659,808 |
| 2011 | 333,728 | 74,742 | 850,295 | 1,258,764 | 141,279 | 221,237 | 311,429 | 673,945 | 1,932,709 |
| 2012 | 286,623 | 75,142 | 819,519 | 1,181,283 | 131,782 | 150,858 | 222,107 | 504,746 | 1,686,030 |

[1] Total mortality estimates prior to 2005 will be included in next year's CTC catch and escapement report when estimates from the ISBM fisheries are available.

# APPENDIX B. ESCAPEMENTS AND TERMINAL RUNS OF PACIFIC SALMON COMMISSION CHINOOK TECHNICAL COMMITTEE CHINOOK SALMON ESCAPEMENT INDICATOR STOCKS, 1975–2012.

Appendix B.1.–Southeast Alaska and Transboundary river estimates of escapement and CVs of Pacific Salmon Commission Chinook Technical Committee wild Chinook salmon escapement indicator stocks. ........ 206

Appendix B.2.–Northern British Columbia escapements and terminal runs (t. run) of Pacific Salmon Commission Chinook Technical Committee wild Chinook salmon escapement indicator stocks. ........ 208

Appendix B.3.–Southern British Columbia escapements of Pacific Salmon Commission Chinook Technical Committee wild Chinook salmon escapement indicator stocks. ........ 210

Appendix B.4.–West Coast Vancouver Island 6-stream index escapements of Pacific Salmon Commission Chinook Technical Committee wild Chinook salmon escapement indicator stocks. ........ 211

Appendix B.5.–Fraser River escapements and terminal runs (t. run) of Pacific Salmon Commission Chinook Technical Committee wild Chinook salmon escapement indicator stocks. ........ 212

Appendix B.6.–Puget Sound escapements and terminal runs (t. run) of Pacific Salmon Commission Chinook Technical Committee wild Chinook salmon escapement indicator stocks. ........ 213

Appendix B.7.–Washington Coast escapements and terminal runs (t. run) of Pacific Salmon Commission Chinook Technical Committee wild Chinook salmon escapement indicator stocks. ........ 215

Appendix B.8.–Columbia River escapements and terminal runs (t. run) of Pacific Salmon Commission Chinook Technical Committee wild Chinook salmon escapement indicator stocks. ........ 217

Appendix B.9.–Oregon Coastal escapements as estimated via traditional habitat expansion methods and terminal runs (t. run) of Pacific Salmon Commission Chinook Technical Committee wild Chinook salmon escapement indicator stocks. ........ 219

Appendix B.10.–Oregon Coastal escapements and terminal runs (t. run) as estimated by mark–recapture calibrated indexes of Pacific Salmon Commission Chinook Technical Committee wild Chinook salmon escapement indicator stocks. Those estimates presented in boldface represent estimates generated from direct mark–recapture study ........ 220

Appendix B.1.–Southeast Alaska and Transboundary river estimates of escapement and CVs of Pacific Salmon Commission Chinook Technical Committee wild Chinook salmon escapement indicator stocks.

| | Southeast Alaska Stocks | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Situk River | | Chilkat R. | | King Salmon R. | | Andrew Creek | | Unuk River | |
| Year | Esc | CV[1] | Esc | CV | Esc | CV[1] | Esc | CV[1] | Esc | CV |
| 1975 | | | | | 64 | 0.17 | 507 | 0.23 | | |
| 1976 | 1,421 | 0 | | | 99 | 0.17 | 404 | | | |
| 1977 | 1,732 | 0 | | | 204 | 0.17 | 465 | | 4,706 | 0.12 |
| 1978 | 808 | 0 | | | 87 | 0.17 | 388 | | 5,344 | 0.12 |
| 1979 | 1,284 | 0 | | | 134 | 0.17 | 327 | | 2,783 | 0.12 |
| 1980 | 905 | 0 | | | 106 | 0.17 | 282 | | 4,909 | 0.12 |
| 1981 | 702 | 0 | | | 154 | 0.17 | 536 | | 3,532 | 0.12 |
| 1982 | 434 | 0 | | | 394 | 0.17 | 672 | | 6,528 | 0.12 |
| 1983 | 592 | 0 | | | 245 | | 366 | | 5,436 | 0.12 |
| 1984 | 1,726 | 0 | | | 265 | | 389 | | 8,876 | 0.12 |
| 1985 | 1,521 | 0 | | | 175 | | 622 | 0.23 | 5,721 | 0.12 |
| 1986 | 2,067 | 0 | | | 255 | | 1,379 | 0.23 | 10,273 | 0.12 |
| 1987 | 1,379 | 0 | | | 196 | | 1,537 | 0.23 | 9,533 | 0.12 |
| 1988 | 868 | 0.02 | | | 208 | | 1,100 | 0.23 | 8,437 | 0.12 |
| 1989 | 637 | 0 | | | 240 | | 1,034 | 0.23 | 5,552 | 0.12 |
| 1990 | 628 | 0 | | | 179 | | 1,295 | 0.23 | 2,856 | 0.12 |
| 1991 | 889 | 0.01 | 5,897 | 0.17 | 134 | | 780 | 0.23 | 3,165 | 0.12 |
| 1992 | 1,595 | 0.01 | 5,284 | 0.18 | 99 | | 1,517 | 0.23 | 4,223 | 0.12 |
| 1993 | 952 | 0.03 | 4,472 | 0.19 | 266 | 0.17 | 2,067 | 0.23 | 5,160 | 0.12 |
| 1994 | 1,271 | 0.03 | 6,795 | 0.16 | 213 | 0.17 | 1,115 | 0.23 | 3,435 | 0.12 |
| 1995 | 4,330 | 0.04 | 3,790 | 0.21 | 147 | 0.17 | 669 | 0.23 | 3,730 | 0.12 |
| 1996 | 1,800 | 0.10 | 4,920 | 0.15 | 292 | 0.17 | 653 | 0.23 | 5,639 | 0.12 |
| 1997 | 1,878 | 0.11 | 8,100 | 0.15 | 362 | 0.17 | 571 | 0.23 | 2,970 | 0.09 |
| 1998 | 924 | 0.14 | 3,675 | 0.15 | 134 | 0.17 | 950 | 0.23 | 4,132 | 0.1 |
| 1999 | 1,461 | 0.10 | 2,271 | 0.18 | 304 | 0.17 | 1,180 | 0.23 | 3,914 | 0.13 |
| 2000 | 1,785 | 0.08 | 2,035 | 0.16 | 138 | 0.17 | 1,346 | 0.23 | 5,872 | 0.11 |
| 2001 | 656 | 0.03 | 4,517 | 0.16 | 149 | 0.17 | 2,055 | 0.23 | 10,541 | 0.11 |
| 2002 | 1,000 | 0.01 | 4,051 | 0.11 | 155 | 0.17 | 1,708 | 0.23 | 6,988 | 0.12 |
| 2003 | 2,117 | 0.03 | 5,657 | 0.12 | 119 | 0.17 | 1,160 | 0.23 | 5,546 | 0.08 |
| 2004 | 698 | 0.03 | 3,422 | 0.13 | 135 | 0.17 | 2,991 | 0.23 | 3,963 | 0.08 |
| 2005 | 595 | 0.01 | 3,366 | 0.17 | 143 | 0.17 | 1,979 | 0.23 | 4,742 | 0.08 |
| 2006 | 295 | | 3,039 | 0.15 | 150 | 0.17 | 2,124 | 0.23 | 5,645 | 0.08 |
| 2007 | 677 | | 1,442 | 0.16 | 181 | 0.17 | 1,736 | 0.23 | 5,668 | 0.08 |
| 2008 | 413 | | 2,905 | 0.19 | 120 | 0.17 | 981 | 0.23 | 3,104 | 0.12 |
| 2009 | 902 | | 4,429 | 0.17 | 109 | 0.17 | 628 | 0.23 | 3,157 | 0.11 |
| 2010 | 167 | | 1,815 | 0.13 | 158 | 0.17 | 1,205 | 0.23 | 3,835 | 0.16 |
| 2011 | 240 | | 2,688 | 0.12 | 192 | 0.17 | 936 | 0.23 | 3,195 | 0.21 |
| 2012 | 322 | | 1,627 | 0.17 | 155 | 0.17 | 587 | 0.23 | 956 | 0.16 |
| Lower | 500 | | 1,750 | | 120 | | 650 | | 1,800 | |
| Upper | 1,000 | | 3,500 | | 240 | | 1,500 | | 3,800 | |

–continued–

Appendix B.1.–Page 2 of 2.

|  | Southeast Alaska Stocks (cont.) |  |  |  |  | Transboundary River Stocks |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|
|  | Chickamin R. index | Blossom R. |  | Keta R. |  | Alsek R. |  | Taku R. |  | Stikine R. |  |
| Year | Esc.[2] | Esc | CV | Esc | CV | Esc | CV | Esc | CV | Esc | CV |
| 1975 | 370 | 565 | 0.62 | 611 | 0.56 |  |  | 12,920 | 0.38 | 7,571 | 0.21 |
| 1976 | 157 | 263 | 0.62 | 253 | 0.56 | 5,282 | 0.35 | 24,582 | 0.38 | 5,723 | 0.16 |
| 1977 | 363 | 433 | 0.62 | 692 | 0.56 | 12,706 | 0.35 | 29,496 | 0.38 | 11,445 | 0.16 |
| 1978 | 308 | 553 | 0.62 | 1,180 | 0.56 | 12,034 | 0.35 | 17,124 | 0.38 | 6,835 | 0.21 |
| 1979 | 239 | 209 | 0.62 | 1,282 | 0.56 | 17,354 | 0.35 | 21,617 | 0.38 | 12,610 | 0.21 |
| 1980 | 445 | 344 | 0.62 | 578 | 0.56 | 10,862 | 0.35 | 39,239 | 0.38 | 30,573 | 0.16 |
| 1981 | 384 | 615 | 0.62 | 990 | 0.56 | 8,502 | 0.35 | 49,559 | 0.38 | 36,057 | 0.21 |
| 1982 | 571 | 1,335 | 0.62 | 2,270 | 0.56 | 9,475 | 0.35 | 23,847 | 0.38 | 40,488 | 0.16 |
| 1983 | 599 | 2,279 | 0.62 | 2,474 | 0.56 | 10,344 | 0.35 | 9,795 | 0.38 | 6,424 | 0.21 |
| 1984 | 1,102 | 1,966 | 0.62 | 1,836 | 0.56 | 7,238 | 0.35 | 20,778 | 0.38 | 13,995 | 0.21 |
| 1985 | 956 | 2,744 | 0.62 | 1,878 | 0.56 | 6,127 | 0.35 | 35,916 | 0.38 | 16,037 | 0.15 |
| 1986 | 1,745 | 4,946 | 0.62 | 2,077 | 0.56 | 11,069 | 0.35 | 38,110 | 0.38 | 14,889 | 0.15 |
| 1987 | 975 | 5,221 | 0.62 | 2,312 | 0.56 | 11,141 | 0.35 | 28,935 | 0.38 | 24,632 | 0.15 |
| 1988 | 786 | 1,486 | 0.62 | 1,731 | 0.56 | 8,717 | 0.35 | 44,524 | 0.38 | 37,554 | 0.15 |
| 1989 | 934 | 1,331 | 0.62 | 3,477 | 0.56 | 10,119 | 0.35 | 40,329 | 0.14 | 24,282 | 0.15 |
| 1990 | 564 | 995 | 0.62 | 1,824 | 0.56 | 8,609 | 0.35 | 52,143 | 0.18 | 22,619 | 0.15 |
| 1991 | 487 | 925 | 0.62 | 819 | 0.56 | 11,625 | 0.35 | 51,645 | 0.38 | 23,206 | 0.15 |
| 1992 | 346 | 581 | 0.62 | 653 | 0.56 | 5,773 | 0.35 | 55,889 | 0.38 | 34,129 | 0.15 |
| 1993 | 389 | 1,173 | 0.62 | 1,090 | 0.56 | 13,855 | 0.35 | 66,125 | 0.38 | 58,962 | 0.15 |
| 1994 | 388 | 623 | 0.62 | 921 | 0.56 | 15,863 | 0.35 | 48,368 | 0.38 | 33,094 | 0.15 |
| 1995 | 356 | 840 | 0.62 | 527 | 0.56 | 24,772 | 0.35 | 33,805 | 0.15 | 16,784 | 0.15 |
| 1996 | 422 | 851 | 0.62 | 894 | 0.56 | 15,922 | 0.35 | 79,019 | 0.12 | 28,949 | 0.01 |
| 1997 | 272 | 511 | 0.62 | 740 | 0.56 | 12,494 | 0.35 | 114,938 | 0.16 | 26,996 | 0.11 |
| 1998 | 391 | 364 | 0.18 | 446 | 0.1 | 6,833 | 0.33 | 31,039 | 0.38 | 25,968 | 0.15 |
| 1999 | 492 | 820 | 0.62 | 968 | 0.11 | 14,597 | 0.24 | 16,786 | 0.19 | 19,947 | 0.16 |
| 2000 | 801 | 894 | 0.62 | 914 | 0.11 | 7,905 | 0.25 | 34,997 | 0.15 | 27,531 | 0.12 |
| 2001 | 1,010 | 789 | 0.62 | 1,032 | 0.56 | 6,705 | 0.41 | 46,554 | 0.15 | 63,523 | 0.09 |
| 2002 | 1,013 | 867 | 0.62 | 1,237 | 0.56 | 5,569 | 0.61 | 55,044 | 0.2 | 50,875 | 0.12 |
| 2003 | 964 | 786 | 0.62 | 969 | 0.56 | 5,904 | 0.44 | 36,435 | 0.18 | 46,824 | 0.13 |
| 2004 | 798 | 734 | 0.09 | 1,132 | 0.56 | 7,083 | 0.52 | 75,032 | 0.14 | 48,900 | 0.08 |
| 2005 | 924 | 926 | 0.09 | 1,496 | 0.56 | 4,478 | 0.35 | 38,725 | 0.12 | 40,501 | 0.07 |
| 2006 | 1,330 | 1,270 | 0.12 | 2,248 | 0.56 | 2,323 | 0.35 | 42,296 | 0.13 | 24,405 | 0.28 |
| 2007 | 893 | 522 | 0.62 | 936 | 0.56 | 2,827 | 0.35 | 14,854 | 0.22 | 14,560 | 0.15 |
| 2008 | 1,111 | 995 | 0.62 | 1,093 | 0.56 | 1,885 | 0.35 | 27,383 | 0.09 | 18,352 | 0.16 |
| 2009 | 611 | 476 | 0.62 | 659 | 0.56 | 6,239 | 0.35 | 22,801 | 0.12 | 11,086 | 0.23 |
| 2010 | 1,156 | 1,405 | 0.62 | 1,430 | 0.56 | 9,518 | 0.35 | 29,302 | 0.09 | 15,180 | 0.13 |
| 2011 | 852 | 569 | 0.62 | 671 | 0.56 | 6,668 | 0.35 | 27,523 | 0.15 | 14,569 | 0.11 |
| 2012 | 444 | 793 | 0.62 | 725 | 0.56 | 2,660 | 0.35 | 19,429 | 0.12 | 22,671 | 0.17 |
| Lower | 450 | 565 |  | 525 |  | 3,500 |  | 19,000 |  | 14,000 |  |
| Upper | 900 | 1,160 |  | 1,200 |  | 5,300 |  | 36,000 |  | 28,000 |  |

[1] Escapement is enumerated using a weir on the Situk River and CVs are only applicable for years having estimates of sport harvest above the weir. A weir was also in place for a few years at the King Salmon River and Andrew Creek.

[2] Escapement is enumerated using index counts on the Chickamin, Blossom, and Keta rivers and these counts are not expanded to an estimate of total escapement; therefore, CVs are not applicable.

Appendix B.2.–Northern British Columbia escapements and terminal runs (t. run) of Pacific Salmon Commission Chinook Technical Committee wild Chinook salmon escapement indicator stocks.

| | Northern British Columbia | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Area 1 Yakoun R. | Area 3[1] Nass R. | | | Area 4 Skeena R. | | Area 8 Dean R. | Area 8 Atnarko R. | | Area 9 Rivers | Area 10 Smith |
| Year | Esc | Above GW[1] | Esc | t. run | Esc | t. run | index | Esc | CV | Inlet | Inlet[2] |
| 1975 | 1,500 | | 14,895 | 17,874 | 20,319 | | | 3,600 | | 3,280 | 960 |
| 1976 | 700 | | 13,819 | 16,583 | 13,078 | | | 11,700 | | 1,640 | 1,000 |
| 1977 | 800 | 13,688 | 14,288 | 18,410 | 29,018 | 39,606 | | 10,800 | | 2,225 | 1,050 |
| 1978 | 600 | 15,485 | 16,885 | 21,807 | 22,661 | 35,055 | 3,500 | 13,500 | | 2,800 | 2,100 |
| 1979 | 400 | 11,253 | 12,783 | 16,229 | 18,488 | 28,166 | 4,000 | 4,050 | | 2,150 | 500 |
| 1980 | 600 | 13,476 | 14,855 | 18,744 | 23,429 | 38,626 | 2,000 | 6,480 | | 2,325 | 1,200 |
| 1981 | 750 | 12,625 | 13,925 | 17,606 | 24,523 | 42,018 | 3,500 | 4,050 | | 3,175 | 1,020 |
| 1982 | 1,400 | 7,959 | 10,359 | 13,287 | 17,092 | 35,185 | | 7,200 | | 2,250 | 1,500 |
| 1983 | 600 | 13,252 | 16,301 | 20,516 | 23,562 | 39,510 | 500 | 7,740 | | 3,320 | 1,050 |
| 1984 | 300 | 20,967 | 24,967 | 31,408 | 37,598 | 53,516 | 4,500 | 13,788 | | 1,400 | 770 |
| 1985 | 1,500 | 17,782 | 19,694 | 24,768 | 53,599 | 76,544 | 4,000 | 24,804 | | 3,371 | 230 |
| 1986 | 500 | 36,523 | 38,123 | 47,967 | 59,968 | 87,566 | 3,300 | 19,170 | | 7,623 | 532 |
| 1987 | 2,000 | 19,540 | 20,986 | 26,568 | 59,120 | 76,349 | 1,144 | 12,983 | | 5,239 | 1,050 |
| 1988 | 2,000 | 15,345 | 16,715 | 21,094 | 68,705 | 102,563 | 1,300 | 13,500 | | 4,429 | 1,050 |
| 1989 | 2,800 | 28,133 | 29,175 | 36,594 | 57,202 | 83,439 | 2,300 | 19,800 | | 3,265 | 225 |
| 1990 | 2,000 | 24,051 | 26,551 | 33.384 | 55,976 | 89,447 | 2,000 | 15,300 | | 4,039 | 510 |
| 1991 | 1,900 | 6,907 | 8,259 | 13,136 | 52,753 | 79,343 | 2,400 | 16,020 | | 6,635 | 500 |
| 1992 | 2,000 | 16,808 | 17,408 | 25,405 | 63,392 | 92,184 | 3,000 | 24,300 | | 7,500 | 500 |
| 1993 | 1,000 | 24,814 | 26,508 | 36,678 | 66,977 | 96,018 | 700 | 31,500 | | 10,000 | 500 |
| 1994 | 2,000 | 21,169 | 25,689 | 32,864 | 48,712 | 68,127 | 1,300 | 24,120 | | 3,500 | 700 |
| 1995 | 1,500 | 7,844 | 8,776 | 16,187 | 34,390 | 48,351 | 1,100 | 28,800 | | 3,196 | 400 |
| 1996 | 3,000 | 21,842 | 22,712 | 30,889 | 73,684 | 96,453 | 2,000 | 22,500 | | 3,000 | 250 |
| 1997 | 2,500 | 18,702 | 20,584 | 27,658 | 42,539 | 65,350 | 1,400 | 16,200 | | 4,980 | 100 |
| 1998 | 3,000 | 23,213 | 25,361 | 34,922 | 46,744 | 65,167 | 3,000 | 19,800 | | 5,367 | 1,100 |
| 1999 | 3,200 | 11,544 | 13,118 | 22,310 | 43,775 | 70,993 | 1,800 | 22,500 | | 2,739 | 500 |
| 2000 | 3,600 | 18,912 | 20,565 | 31,159 | 51,804 | 77,320 | 1,200 | 22,500 | | 6,700 | 500 |

–continued–

Appendix B.2.–Page 2 of 2.

|  | Northern British Columbia |  |  |  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|
|  | Area 1 Yakoun R. | Area 3[1] Nass R. |  |  | Area 4 Skeena R. |  | Area 8 Dean R. | Area 8 Atnarko R. |  | Area 9 Rivers | Area 10 Smith |
| Year | Esc | Above GW[1] | Esc | t. run | Esc | t. run | index | Esc | CV | Inlet | Inlet[2] |
| 2001 | 3,500 | 29,687 | 31,915 | 44,595 | 81,504 | 112,346 | 3,795 | 20,044 | .059 | 5,062 | 300 |
| 2002 | 3,000 | 13,773 | 15,382 | 21,528 | 44,771 | 63,069 | 3,731 | 14,651 | .122 | 5,031 |  |
| 2003 | 4,000 | 26,940 | 28,330 | 36,503 | 56,758 | 82,410 | 3,700 | 12,027 | .084 | 1,900 |  |
| 2004 | 4,500 | 15,912 | 18,185 | 25,137 | 44,243 | 61,065 | 3,500 | 15,840 |  | 3,950 |  |
| 2005 | 5,000 | 14,363 | 16,595 | 24,067 | 29,067 | 39,278 | 2,200 | 15,750 |  | 5,585 |  |
| 2006 | NA | 24,725 | 27,743 | 37,098 | 33,094 | 43,689 | 3,700 | 23,400 |  | 3,930 |  |
| 2007 | NA | 21,459 | 25,524 | 34,221 | 33,352 | 44,185 | 2,300 | 9,900 |  | 5,000 |  |
| 2008 | NA | 17,862 | 20,198 | 26,202 | 32,963 | 54,279 | 1,100 | 8,100 |  | 5,792 |  |
| 2009 | NA | 28,710 | 30,334 | 36,865 | 38,297 | 55,921 | 1,400 | 9,231 | .072 | 4,580 |  |
| 2010 | NA | 19,341 | 20,821 | 26,052 | 43,331 | 54,252 | 1,600 | 9,198 | .113 | 4,225 |  |
| 2011 | NA | 9,639 | 10,415 | 15,092 | 37,073 | 46,683 | 750 | 9,105 | .126 | 4,400 |  |
| 2012 | NA | 8,309 | 9,815 | 15,086 | 34,024 | 38,065 | NA | 5,800 | .156 | 3,970 |  |

[1] GW refers to Gitwinksihlkw, the location of the lower fish wheels on the Nass River used to capture Chinook salmon for the mark–recapture estimate.

[2] The Docee River was dropped as an escapement indicator beginning in 2002 due to an inability to obtain reliable escapement estimates.

Appendix B.3.–Southern British Columbia escapements of Pacific Salmon Commission Chinook Technical Committee wild Chinook salmon escapement indicator stocks.

|  | LGS |  | UGS[1] |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|
| Year | Nanaimo | Cowichan | Nimpkish | Klinaklini | Kakweiken | Kingcome | Wakeman | Esc. index |
| 1975 | 5,475 |  | 1,100 | 16,560 | 200 | 1,500 | 1,500 | 20,860 |
| 1976 | 4,340 |  | 3,500 | 14,569 | 650 | 1,500 | 2,000 | 22,219 |
| 1977 | 6,530 |  | 750 | 21,078 | 130 | 750 | 750 | 23,458 |
| 1978 | 6,495 |  | 1,300 | 13,848 | 350 | 1,000 | 1,000 | 17,498 |
| 1979 | 2,741 | 7,945 | 500 | 7,955 | 60 | 50 | 233 | 8,798 |
| 1980 | 2,982 | 5,837 | 300 | 4,883 | 500 | 32 | 35 | 5,750 |
| 1981 | 225 | 5,782 | 700 | 8,619 | 200 | 20 | 25 | 9,564 |
| 1982 | 1,152 | 5,034 | 700 | 12,887 | 196 | 450 | 750 | 14,983 |
| 1983 | 1,840 | 4,742 | 1,500 | 10,536 | 160 | 359 | 309 | 12,864 |
| 1984 | 3,178 | 5,278 | 3,000 | 5,776 | 88 | 197 | 169 | 9,230 |
| 1985 | 914 | 3,675 | 3,000 | 9,327 | 500 | 150 | 300 | 13,277 |
| 1986 | 958 | 2,147 | 700 | 22,697 | 344 | 774 | 100 | 24,616 |
| 1987 | 757 | 2,519 | 3,000 | 27,069 | 411 | 1,500 | 1,000 | 32,980 |
| 1988 | 1,079 | 6,878 | 1,500 | 6,800 | 103 | 200 | 500 | 9,103 |
| 1989 | 1,552 | 5,535 | 3,850 | 40,002 | 607 | 500 | 800 | 45,759 |
| 1990 | 1,397 | 5,626 | 1,200 | 11,650 | 177 | 300 | 300 | 13,626 |
| 1991 | 935 | 7,408 | 1,400 | 22,784 | 140 | 526 | 300 | 25,150 |
| 1992 | 1,127 | 10,250 | 3,400 | 13,643 | 50 | 316 | 152 | 17,561 |
| 1993 | 1,405 | 7,030 | 300 | 3,406 | 53 | 193 | 223 | 4,175 |
| 1994 | 1,072 | 6,407 | 300 | 3,427 | 30 | 108 | 79 | 3,944 |
| 1995 | 2,300 | 16,449 | 300 | 4,755 | 157 | 426 | 54 | 5,692 |
| 1996 | 1,870 | 14,595 | 399 | 3,857 | 50 | 124 | 108 | 4,538 |
| 1997 | 1,772 | 9,973 | 350 | 3,800 | 39 | 450 | 125 | 4,764 |
| 1998 | 1,800 | 5,858 | 450 | 9,980 | 6 | 450 | 250 | 11,136 |
| 1999 | 2,371 | 6,110 | 640 | 11,068 | 146 | 70 | 281 | 12,205 |
| 2000 | 1,446 | 6,638 | 350 | 17,202 | 30 | 228 | 31 | 17,841 |
| 2001 | 2,448 | 5,015 | 365 | 9,355 | 129 | 527 | 116 | 10,492 |
| 2002 | 1,747 | 4,115 | 570 | 12,529 | 33 | 301 | 73 | 13,506 |
| 2003 | 1,672 | 3,356 | 385 | 13,365 | 164 | 122 | 21 | 14,057 |
| 2004 | 550 | 2,721 | 969 | 6,310 | 96 | 744 | 32 | 8,150 |
| 2005 | 1,036 | 2,467 | 576 | 3,980 | 60 | 95 | 28 | 4,739 |
| 2006 | 2,135 | 1,775 | 500 | 14,228 | 216 | 316 | 145 | 15,405 |
| 2007 | 2,267 | 2,175 | 514 | 5,791 | 88 | 75 | 90 | 6,558 |
| 2008 | 2,671 | 2,015 | 532 | 4,915 | 75 | 35 | 35 | 5,592 |
| 2009 | 1,470 | 785 | 929 | 10,134 | 154 | 64 | 19 | 11,300 |
| 2010 | 2,201 | 2,879 | 543 | 7,119 | 108 | 55 | 26 | 7,851 |
| 2011 | 3,937 | 3,492 | 720 | 4,829 | 5 | 6 | 20 | 5,580 |
| 2012 | 1,063 | 3,508 | 2,313 | 17,614 | 267 | 4 | 20 | 20,219 |
| Goal |  | 6,500 |  |  |  |  |  |  |

*Note*: Refer to List of Acronyms for definitions.

[1] Upper Strait of Gerogia (UGS) escapement updated with time series for 5 stream index.

Appendix B.4.–West Coast Vancouver Island 6-stream index escapements of Pacific Salmon Commission Chinook Technical Committee wild Chinook salmon escapement indicator stocks.

| Year | WCVI[1] | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Marble** | **Burman** | **Tahsis** | **Artlish** | **Kaouk** | **Tahsish** | **Esc. index** |
| 1975 | 400 | 200 | 75 | 25 | 75 | 25 | 800 |
| 1976 | 400 | 400 | 200 | 25 | 25 | 25 | 1,075 |
| 1977 | 950 | 500 | 150 | 60 | 75 | 100 | 1,835 |
| 1978 | 1,500 | 1,000 | 100 | 50 | 50 | 50 | 2,750 |
| 1979 | 750 | 650 | 348 | 40 | 60 | 200 | 2,048 |
| 1980 | 5,000 | 345 | 373 | 100 | 100 | 200 | 6,118 |
| 1981 | 3,000 | 300 | 150 | 500 | 100 | 1,000 | 5,050 |
| 1982 | 5,000 | 70 | 125 | 100 | 100 | 1,000 | 6,395 |
| 1983 | 1,000 | 475 | 50 | 400 | 300 | 500 | 2,725 |
| 1984 | 600 | 700 | 12 | 650 | 400 | 1,500 | 3,862 |
| 1985 | 1,250 | 500 | 50 | 400 | 300 | 1,200 | 3,700 |
| 1986 | 1,100 | 400 | 60 | 100 | 100 | 1,000 | 2,760 |
| 1987 | 1,750 | 100 | 20 | 100 | 100 | 500 | 2,570 |
| 1988 | 3,275 | 500 | 125 | | | 400 | 4,300 |
| 1989 | 4,181 | 780 | 500 | 40 | 30 | 450 | 5,981 |
| 1990 | 1,973 | 1,100 | 300 | 50 | 10 | 200 | 3,633 |
| 1991 | 710 | 2,767 | 1,515 | 20 | 20 | 120 | 5,152 |
| 1992 | 800 | 2,198 | 1,463 | 10 | 80 | 600 | 5,151 |
| 1993 | 2,000 | 1,750 | 578 | 10 | 20 | 250 | 4,608 |
| 1994 | 650 | 2,330 | 380 | 100 | 150 | 250 | 3,860 |
| 1995 | 1,626 | 594 | 525 | 99 | 266 | 600 | 3,710 |
| 1996 | 3,971 | 724 | 771 | 53 | 219 | 288 | 6,026 |
| 1997 | 2,638 | 2,354 | 722 | 402 | 558 | 523 | 7,197 |
| 1998 | 5,297 | 3,205 | 587 | 300 | 824 | 1,430 | 11,643 |
| 1999 | 4,185 | 2,399 | 1,731 | 539 | 453 | 879 | 10,186 |
| 2000 | 2,572 | 212 | 1,220 | 75 | 105 | 391 | 4,575 |
| 2001 | 1,450 | 107 | 389 | 139 | 409 | 237 | 2,731 |
| 2002 | 2,485 | 440 | 758 | 41 | 251 | 308 | 4,283 |
| 2003 | 1,749 | 768 | 762 | 379 | 358 | 440 | 4,456 |
| 2004 | 3,658 | 2,636 | 905 | 454 | 301 | 495 | 8,449 |
| 2005 | 2,354 | 642 | 182 | 199 | 488 | 121 | 3,986 |
| 2006 | 3,071 | 516 | 141 | 228 | 536 | 76 | 4,568 |
| 2007 | 2,764 | 353 | 133 | 162 | 193 | 234 | 3,839 |
| 2008 | 2,683 | 515 | 281 | 200 | 264 | 380 | 4,323 |
| 2009 | 3,440 | 1,800 | 780 | 214 | 550 | 80 | 6,864 |
| 2010 | 3,560 | 3,028 | 380 | 110 | 185 | 355 | 7,618 |
| 2011 | 3,910 | 2,020 | 220 | 100 | 300 | 260 | 6,810 |
| 2012 | 2,364 | 1,003 | 163 | 141 | 223 | 138 | 4,032 |
| Goal | | | | | | | |

[1] The escapement methodology changed for the WCVI streams in 1995, and the earlier estimates have not been calibrated to the new methodology.

Appendix B.5.–Fraser River escapements and terminal runs (t. run) of Pacific Salmon Commission Chinook Technical Committee wild Chinook salmon escapement indicator stocks.

| | Fraser River | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Fraser Spring Age 1.2 | Fraser Spring Age 1.3 | Fraser Summer Age .3 | Fraser Summer Age 1.3 | Fraser Spr/Sum | Harrison | | | Lower Shuswap[1] | |
| Year | Esc | Esc | Esc | Esc | t. run | Esc | CV | t. run | Esc | CV |
| 1975 | 7,179 | 8,184 | 26,875 | 16,875 | 119,081 | | | | 27,582 | 0.342 |
| 1976 | 4,600 | 10,307 | 4,925 | 13,630 | 98,691 | | | | 3,604 | 0.418 |
| 1977 | 3,675 | 13,261 | 19,600 | 17,240 | 132,553 | | | | 14,356 | 0.345 |
| 1978 | 4,305 | 15,725 | 16,700 | 19,200 | 109,119 | | | | 15,802 | 0.343 |
| 1979 | 2,770 | 14,985 | 18,275 | 10,205 | 101,252 | | | | 15,158 | 0.344 |
| 1980 | 6,255 | 16,521 | 8,350 | 13,625 | 71,504 | | | | 5,822 | 0.383 |
| 1981 | 2,975 | 12,274 | 13,120 | 12,202 | 62,668 | | | | 8,093 | 0.365 |
| 1982 | 5,510 | 15,010 | 6,850 | 15,088 | 85,140 | | | | 3,168 | 0.430 |
| 1983 | 2,641 | 24,225 | 9,500 | 16,604 | 72,526 | | | | 5,396 | 0.146 |
| 1984 | 6,380 | 30,370 | 15,522 | 13,595 | 95,681 | 120,837 | | 131,740 | 7,581 | 0.080 |
| 1985 | 9,477 | 43,168 | 20,375 | 19,099 | 121,941 | 174,778 | | 181,367 | 10,539 | 0.075 |
| 1986 | 10,275 | 48,446 | 22,460 | 32,505 | 144,617 | 162,596 | | 177,662 | 18,400 | 0.341 |
| 1987 | 5,049 | 48,271 | 22,404 | 27,646 | 128,699 | 79,038 | | 81,799 | 15,158 | 0.344 |
| 1988 | 4,003 | 41,783 | 29,567 | 32,066 | 129,587 | 35,116 | | 38,285 | 21,697 | 0.340 |
| 1989 | 6,126 | 31,994 | 24,200 | 16,200 | 106,843 | 74,685 | | 76,294 | 16,772 | 0.342 |
| 1990 | 3,225 | 41,560 | 25,425 | 33,747 | 135,124 | 177,375 | | 180,837 | 20,042 | 0.340 |
| 1991 | 3,495 | 27,296 | 26,250 | 28,097 | 116,555 | 90,638 | | 93,363 | 15,158 | 0.344 |
| 1992 | 5,937 | 33,038 | 32,200 | 38,011 | 130,249 | 130,411 | | 132,042 | 20,537 | 0.340 |
| 1993 | 7,870 | 32,796 | 13,300 | 21,385 | 110,237 | 118,998 | | 120,600 | 8,860 | 0.361 |
| 1994 | 10,696 | 51,655 | 25,350 | 23,657 | 145,303 | 98,334 | | 100,839 | 25,296 | 0.341 |
| 1995 | 9,670 | 45,237 | 20,550 | 26,371 | 134,478 | 28,616 | | 29,840 | 15,158 | 0.344 |
| 1996 | 20,726 | 38,398 | 50,900 | 43,142 | 185,559 | 56,809 | | | 30,146 | 0.343 |
| 1997 | 9,878 | 44,373 | 49,250 | 40,882 | 202,795 | 72,277 | .091 | | 20,207 | 0.340 |
| 1998 | 3,003 | 37,862 | 68,033 | 36,750 | 169,333 | 188,420 | | 189,103 | 26,232 | 0.341 |
| 1999 | 8,751 | 20,740 | 53,204 | 25,138 | 140,939 | 106,995 | .102 | | 40,090 | 0.349 |
| 2000 | 11,731 | 26,773 | 45,161 | 25,869 | 155,209 | 125,854 | | | 27,676 | 0.040 |
| 2001 | 10,607 | 31,512 | 74,132 | 33,980 | 177,008 | 113,777 | | | 35,788 | 0.026 |
| 2002 | 16,423 | 42,408 | 85,132 | 34,886 | 221,020 | 89,968 | .082 | 91,122 | 54,219 | 0.017 |
| 2003 | 17,137 | 45,441 | 70,164 | 44,451 | 231,689 | 247,121 | .083 | 251,453 | 32,921 | 0.344 |
| 2004 | 12,156 | 31,614 | 53,764 | 30,980 | 194,440 | 128,990 | | 131,894 | 16,963 | 0.045 |
| 2005 | 3,898 | 21,458 | 88,329 | 18,586 | 172,281 | 88,580 | .063 | 94,880 | 17,892 | 0.031 |
| 2006 | 6,642 | 21,699 | 149,928 | 20,565 | 242,878 | 60,422 | .135 | 62,419 | 59,085 | 0.024 |
| 2007 | 1,407 | 11,737 | 85,722 | 10,536 | 137,206 | 76,483 | .068 | 80,718 | 15,926 | 0.027 |
| 2008 | 6,121 | 17,181 | 106,539 | 15,431 | 187,591 | 41,603 | .073 | 43,798 | 14,921 | 0.037 |
| 2009 | 911 | 24,150 | 86,443 | 20,619 | 172,858 | 70,141 | .064 | 75,550 | 25,113 | 0.018 |
| 2010 | 6,576 | 18,029 | 156,657 | 18,229 | 199,491 | 103,515 | .056 | 106,777 | 71,379 | 0.021 |
| 2011 | 2,233 | 12,104 | 127,958 | 18,570 | 215,499 | 123,647 | .052 | 132,021 | 18,874 | 0.029 |
| 2012 | 7,314 | 11,584 | 47,949 | 1,080 | 127,845 | 44,467 | .086 | 56,859 | 3,958 | 0.030 |
| Goal | | | | | | 75,100 | | | | |
| Goal | | | | | | 98,500 | | | | |

[1] Escapement was estimated by mark–recapture methods from 1983 to 1985, 2000 to 2002, and 2004 to 2012. All other years are calibrated values that have been estimated using a relationship between mark–recapture and peak methods.

Appendix B.6.–Puget Sound escapements and terminal runs (t. run) of Pacific Salmon Commission Chinook Technical Committee wild Chinook salmon escapement indicator stocks.

| Puget Sound (includes hatchery strays in natural escapement) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Skagit River Spring | | Skagit River Sum/fall | | Stillaguamish River | | | Snohomish River | | Green river | | | Nooksack Spring Esc | | Lake Washington Fall | |
| Year | Esc | t. run | Esc | t. run[1] | MR esc[2] | Esc | t. run[1] | Esc | t. run | MR esc[2] | Esc | t. run | N. Fork | S. Fork | Esc | t. run |
| 1975 | 627 | 627 | 11,320 | 30,299 | | 1,198 | 1,801 | 4,485 | 6,627 | | 3,394 | 6,838 | | | 656 | 1004 |
| 1976 | 633 | 633 | 14,120 | 28,589 | | 2,140 | 4,241 | 5,315 | 10,544 | | 3,140 | 8,246 | | | 719 | 937 |
| 1977 | 520 | 520 | 9,218 | 21,502 | | 1,475 | 2,847 | 5,565 | 10,676 | | 3,804 | 5,936 | | | 675 | 889 |
| 1978 | 932 | 932 | 13,075 | 24,285 | | 1,232 | 2,159 | 7,931 | 13,672 | | 3,304 | 4,766 | | | 890 | 1353 |
| 1979 | 818 | 818 | 13,306 | 24,350 | | 1,042 | 2,531 | 5,903 | 13,743 | | 9,704 | 11,689 | | | 1,289 | 1578 |
| 1980 | 1,408 | 1,408 | 20,058 | 31,250 | | 821 | 2,818 | 6460 | 17,653 | | 7,743 | 11,248 | | | 1,360 | 1683 |
| 1981 | 1,045 | 1,045 | 8,283 | 21,817 | | 630 | 3,014 | 3368 | 9,991 | | 3,606 | 5,532 | | | 721 | 924 |
| 1982 | 753 | 753 | 9,910 | 24,259 | | 773 | 3,229 | 4379 | 9,429 | | 1,840 | 4,271 | | | 885 | 1384 |
| 1983 | 554 | 554 | 8,723 | 15,758 | | 387 | 1,089 | 4549 | 11,236 | | 3,679 | 14,376 | | | 1,332 | 2515 |
| 1984 | 696 | 696 | 12,628 | 15,616 | | 374 | 920 | 3762 | 8,975 | | 3,353 | 5,890 | 45 | 188 | 1,252 | 4211 |
| 1985 | 2,634 | 2,634 | 16,002 | 26,230 | | 1,409 | 2,717 | 4,873 | 9,637 | | 2,908 | 7,914 | 258 | 445 | 949 | 2627 |
| 1986 | 1,922 | 1,922 | 17,908 | 22,906 | | 1,277 | 2,499 | 4,534 | 8,969 | | 4,792 | 6,114 | 226 | 170 | 1,470 | 2863 |
| 1987 | 1,745 | 1,745 | 9,409 | 13,387 | | 1,321 | 1,982 | 4,689 | 7,107 | | 10,338 | 12,283 | 181 | 248 | 2,038 | 4835 |
| 1988 | 1,743 | 1,743 | 11,468 | 15,262 | | 717 | 1,245 | 4,513 | 7,933 | | 7,994 | 9,667 | 456 | 233 | 792 | 2829 |
| 1989 | 1,400 | 1,809 | 6,684 | 13,270 | | 784 | 1,664 | 3,138 | 6,379 | | 11,512 | 15,244 | 303 | 606 | 1,011 | 1544 |
| 1990 | 1,511 | 1,546 | 16,521 | 18,950 | | 842 | 1,867 | 4,209 | 8,562 | | 7,035 | 15,483 | 10 | 142 | 787 | 1098 |
| 1991 | 1,236 | 1,273 | 5,824 | 8,604 | | 1,536 | 2,969 | 2,783 | 5,151 | | 10,548 | 15,451 | 108 | 365 | 661 | 1115 |
| 1992 | 986 | 1,010 | 7,348 | 9,021 | | 639 | 1,279 | 2,708 | 4,448 | | 5,267 | 10,165 | 498 | 103 | 790 | 1212 |
| 1993 | 782 | 812 | 5,801 | 7,097 | | 719 | 1,259 | 3,866 | 5,609 | | 2,476 | 5,507 | 449 | 235 | 245 | 324 |
| 1994 | 470 | 496 | 5,549 | 5,912 | | 773 | 1,323 | 3,626 | 5,039 | | 4,078 | 8,368 | 45 | 118 | 888 | 926 |
| 1995 | 855 | 887 | 6,877 | 9,239 | | 775 | 1,495 | 3,176 | 3,370 | | 7,939 | 9,935 | 230 | 290 | 930 | 966 |
| 1996 | 1,051 | 1,078 | 10,613 | 10,828 | | 1,244 | 2,276 | 4,851 | 4,877 | | 6,026 | 8,664 | 534 | 203 | 336 | 362 |
| 1997 | 1,041 | 1,064 | 4,872 | 6,092 | | 1,156 | 17,298 | 4,292 | 4,382 | | 7,101 | 7,778 | 520 | 180 | 294 | 302 |
| 1998 | 1,086 | 1,091 | 14,609 | 14,965 | | 1,544 | 2,434 | 6,304 | 6,376 | | 5,963 | 7,777 | 368 | 157 | 697 | 711 |
| 1999 | 471 | 476 | 4,924 | 5,229 | | 1,098 | 2,264 | 4,799 | 4,839 | | 7,135 | 8,376 | 823 | 166 | 778 | 791 |
| 2000 | 1,021 | 1,025 | 16,930 | 17,265 | | 1,645 | 3,065 | 6,092 | 6,120 | 10,526 | 4,473 | 6,880 | 1,245 | 284 | 347 | 393 |
| 2001 | 1,856 | 1,866 | 13,793 | 14,046 | | 1,349 | 2,051 | 8,164 | 8,464 | 21,402 | 6,473 | 9,721 | 2,209 | 267 | 1,269 | 1555 |
| 2002 | 1,076 | 1,092 | 19,591 | 19,911 | | 1,588 | 2,219 | 7,220 | 7,266 | 14,857 | 7,564 | 11,539 | 3,741 | 289 | 637 | 663 |
| 2003 | 909 | 987 | 9,777 | 10,106 | | 988 | 1,320 | 5,447 | 5,597 | | 5,864 | 7,871 | 2,857 | 204 | 771 | 826 |

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Appendix B.6.–Page 2 of 2.

| Puget Sound (includes hatchery strays in natural escapement) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Skagit Spring | | Skagit Sum/fall | | Stillaguamish | | | Snohomish | | Green | | | Nooksack Spring Esc | | Lake Washington Fall | |
| Year | Esc | t. run | Esc | t. run[1] | MR esc[2] | Esc | t. run[1] | Esc | t. run | MR esc[2] | Esc | t. run | N. Fork | S. Fork | Esc | t. run |
| 2004 | 1,622 | 1,622 | 23,553 | 24,107 | | 1,506 | 1,974 | 10,606 | 10,701 | | 7,947 | 13,498 | 1,746 | 130 | 730 | 794 |
| 2005 | 1,305 | 1,305 | 20,803 | 23,405 | | 1,036 | 1,493 | 4,484 | 4,680 | | 2,523 | 2,987 | 2,167 | 120 | 726 | 788 |
| 2006 | 1,896 | 1,919 | 20,768 | 22,539 | | 1,254 | 1,543 | 8,308 | 8,481 | | 5,790 | 8,604 | 1,184 | 355 | 1,219 | 1433 |
| 2007 | 613 | 613 | 11,281 | 13,027 | 1,881 | 607 | 866 | 3,982 | 4,004 | | 4,301 | 7,205 | 1,438 | 182 | 1,968 | 3342 |
| 2008 | 1,472 | 1,472 | 11,664 | 14,995 | 1,836 | 1,671 | 1,861 | 8,373 | 8,494 | | 5,971 | 10,290 | 1,266 | 318 | 941 | 2917 |
| 2009 | 983 | 983 | 6,955 | 12,460 | 1,110 | 1,001 | 1,218 | 2,161 | 2,347 | | 688 | 1,067 | 1,903 | 294 | 793 | 951 |
| 2010 | 1,361 | 1,537 | 8,037 | 9,060 | 1,381 | 783 | 1,014 | 4,299 | 4,697 | 4,541 | 2,092 | 2,112 | 2,044 | 377 | 729 | 734 |
| 2011 | 825 | 1,015 | 5,536 | 9,181 | | 1,017 | 1,413 | 1,880 | 1,892 | | 993 | 1,464 | 875 | 124 | 906 | 1,034 |
| 2012 | 2,774 | 3,278 | 13,817 | 15,442 | | 1,534 | 1,924 | 5,123 | 5,306 | | 3,091 | 3,804 | 759 | 466 | 1,674 | 1,875 |

[1] Escapement excludes brood stock collected for supplementation program. Total run includes redd count based escapement of all natural spawners, terminal catch, and adult brood stock collected for supplementation and PSC indicator program

[2] Escapement estimated from mark–recapture studies funded under Sentinel Stocks Program and/or U.S. Letter of Agreement.

Appendix B.7.–Washington Coast escapements and terminal runs (t. run) of Pacific Salmon Commission Chinook Technical Committee wild Chinook salmon escapement indicator stocks.

| | Washington Coast | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Quillayute Summer | | Quillayute Fall | | Hoh Spr/Sum | | Hoh Fall | | Hoko Fall | | Queets Spr/Sum | | Queets Fall | | Grays Harbor Spring | | Grays Harbor Fall | |
| Year | Esc | t. run | Esc | t. run | Esc | t. run | Esc | t. run | Esc[1] | t. run | Esc | t. run | Esc | t. run | Esc | t. run | Esc | t. run |
| 1976 | 1,300 | 1,700 | | | 600 | 1,300 | 2,500 | 3,100 | | | 505 | 737 | 1,200 | 2,500 | 600 | 1,000 | 1,836 | 10,313 |
| 1977 | 3,800 | 5,300 | | | 1,000 | 2,000 | 2,100 | 3,800 | | | 732 | 1,155 | 3,600 | 5,500 | 800 | 1,700 | 5,195 | 14,400 |
| 1978 | 2,300 | 2,700 | | | 1,400 | 2,472 | 1,900 | 2,900 | | | 1,110 | 1,406 | 2,200 | 3,100 | 1,000 | 1,600 | 4,555 | 8,372 |
| 1979 | 2,100 | 3,900 | | | 1,400 | 2,326 | 1,700 | 2,200 | | | 870 | 1,369 | 3,900 | 4,700 | 400 | 1,100 | 9,381 | 10,101 |
| 1980 | 964 | 1,500 | 6,700 | 7,600 | 800 | 1,079 | 2,200 | 2,800 | | | 1,038 | 1,213 | 3,200 | 5,800 | 200 | 600 | 11,656 | 21,639 |
| 1981 | 815 | 1,700 | 5,963 | 7,102 | 1,498 | 2,005 | 3,100 | 4,000 | | | 988 | 1,329 | 4,250 | 8,200 | 600 | 900 | 7,577 | 11,915 |
| 1982 | 1,126 | 2,700 | 7,107 | 9,651 | 1,553 | 2,125 | 4,500 | 5,800 | | | 781 | 1,244 | 4,150 | 6,600 | 610 | 669 | 5,606 | 13,296 |
| 1983 | 548 | 1,800 | 3,069 | 5,530 | 1,696 | 2,233 | 2,500 | 3,300 | | | 1,044 | 1,173 | 2,750 | 4,400 | 800 | 850 | 5,482 | 8,997 |
| 1984 | 618 | 1,000 | 9,128 | 10,447 | 1,430 | 2,005 | 1,900 | 2,600 | | | 958 | 1,189 | 4,350 | 6,300 | 1,128 | 1,130 | 21,058 | 22,616 |
| 1985 | 550 | 700 | 6,145 | 8,367 | 978 | 1,353 | 1,725 | 2,720 | | | 677 | 886 | 4,150 | 5,910 | 1,157 | 1,159 | 9,537 | 15,153 |
| 1986 | 853 | 1,000 | 10,006 | 13,380 | 1,248 | 1,912 | 4,981 | 6,000 | 801 | 801 | 925 | 1,193 | 7,894 | 9,180 | 1,795 | 1,826 | 13,951 | 21,534 |
| 1987 | 666 | 1,600 | 12,352 | 20,349 | 1,710 | 2,480 | 4,006 | 6,147 | 581 | 581 | 598 | 1,543 | 6,557 | 10,638 | 841 | 1,071 | 19,023 | 30,861 |
| 1988 | 2,599 | 3,943 | 15,168 | 22,115 | 2,605 | 3,708 | 4,128 | 6,873 | 686 | 776 | 1,765 | 2,267 | 9,494 | 12,505 | 3,106 | 3,208 | 27,216 | 36,778 |
| 1989 | 2,407 | 3,472 | 9,951 | 17,260 | 4,697 | 6,820 | 5,148 | 8,682 | 775 | 842 | 2,568 | 3,954 | 9,324 | 12,213 | 2,068 | 2,393 | 25,599 | 52,777 |
| 1990 | 1,483 | 1,840 | 13,711 | 16,914 | 3,886 | 5,294 | 4,236 | 6,327 | 378 | 493 | 1,780 | 2,480 | 10,569 | 13,155 | 1,567 | 1,630 | 16,580 | 36,821 |
| 1991 | 1,188 | 1,500 | 6,292 | 7,631 | 1,078 | 1,693 | 1,420 | 2,628 | 894 | 1,006 | 630 | 761 | 4,795 | 6,593 | 1,289 | 1,489 | 13,432 | 29,158 |
| 1992 | 1,009 | 1,271 | 6,342 | 7,750 | 1,018 | 1,443 | 4,003 | 5,139 | 642 | 740 | 375 | 505 | 4,911 | 6,880 | 1,813 | 1,851 | 13,175 | 24,162 |
| 1993 | 1,292 | 1,531 | 5,254 | 5,735 | 1,411 | 2,065 | 2,280 | 3,951 | 775 | 894 | 713 | 788 | 3,463 | 5,667 | 1,254 | 1,399 | 11,844 | 24,487 |
| 1994 | 974 | 1,187 | 4,932 | 5,692 | 1,699 | 2,372 | 3,967 | 4,322 | 332 | 428 | 705 | 727 | 4,233 | 6,854 | 1,403 | 1,479 | 11,817 | 24,015 |
| 1995 | 1,333 | 1,731 | 5,532 | 6,716 | 1,132 | 1,686 | 2,202 | 2,912 | 750 | 905 | 625 | 662 | 3,127 | 5,101 | 2,070 | 2,167 | 9,952 | 23,570 |
| 1996 | 1,170 | 1,388 | 7,316 | 9,293 | 1,371 | 2,083 | 3,022 | 4,061 | 1,227 | 1,265 | 776 | 891 | 4,218 | 5,927 | 4,462 | 4,655 | 16,988 | 26,618 |
| 1997 | 890 | 1,177 | 5,405 | 6,047 | 1,826 | 2,582 | 1,773 | 3,034 | 768 | 894 | 540 | 693 | 2,872 | 4,945 | 4,460 | 4,812 | 16,342 | 26,948 |
| 1998 | 1,599 | 1,829 | 6,752 | 7,940 | 1,287 | 1,880 | 4,257 | 5,388 | 1,618 | 1,722 | 492 | 537 | 3,859 | 5,173 | 2,388 | 2,679 | 11,476 | 17,368 |
| 1999 | 713 | 818 | 3,334 | 4,758 | 928 | 1,081 | 1,924 | 2,941 | 1,497 | 1,688 | 373 | 426 | 1,918 | 3,105 | 1,285 | 1,555 | 9,196 | 10,859 |
| 2000 | 989 | 1,149 | 3,730 | 4,794 | 492 | 529 | 1,749 | 2,632 | 612 | 731 | 248 | 250 | 3,755 | 4,147 | 3,135 | 3,424 | 8,081 | 13,010 |
| 2001 | 1,255 | 1,429 | 5,136 | 7,545 | 1,159 | 1,231 | 2,560 | 4,116 | 768 | 946 | 548 | 565 | 3,099 | 4,808 | 2,860 | 3,326 | 8,340 | 17,109 |

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Appendix B.7.–Page 2 of 2.

| Washington Coast | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Quillayute Summer | | Quillayute Fall | | Hoh Spr/Sum | | Hoh Fall | | Hoko Fall | | Queets Spr/Sum | | Queets Fall | | Grays Harbor Spring | | Grays Harbor Fall | |
| Year | Esc | t. run | Esc | t. run | Esc | t. run | Esc | t. run | Esc[1] | t. run | Esc | t. run | Esc | t. run | Esc | t. run | Esc | t. run |
| 2002 | 1,002 | 1,100 | 6,067 | 9,492 | 2,464 | 3,375 | 4,415 | 5,716 | 443 | 680 | 738 | 755 | 2,589 | 5,561 | 2,598 | 3,217 | 10,621 | 13,942 |
| 2003 | 1,219 | 1,262 | 7,398 | 9,469 | 1,228 | 1,646 | 1,649 | 2,345 | 863 | 1,098 | 189 | 195 | 4,979 | 6,618 | 1,904 | 2,101 | 17,808 | 19,488 |
| 2004 | 1,093 | 1,189 | 3,831 | 6,133 | 1,786 | 2,239 | 3,237 | 4,410 | 866 | 1,086 | 604 | 619 | 5,105 | 6,797 | 5,034 | 5,330 | 29,461 | 38,161 |
| 2005 | 876 | 965 | 6,406 | 8,319 | 1,193 | 1,389 | 4,180 | 5,337 | 203 | 284 | 298 | 306 | 4,557 | 6,734 | 2,130 | 2,683 | 17,040 | 19,599 |
| 2006 | 553 | 604 | 5,642 | 7,646 | 904 | 1,061 | 1,535 | 2,324 | 845 | 895 | 330 | 336 | 3,051 | 4,258 | 2,481 | 2,863 | 15,955 | 20,482 |
| 2007 | 502 | 568 | 3,066 | 4,137 | 810 | 1,023 | 1,556 | 2,427 | 462 | 568 | 352 | 358 | 878 | 1,600 | 652 | 999 | 11,264 | 15,126 |
| 2008 | 949 | 1,134 | 3,612 | 5,250 | 671 | 717 | 2,849 | 3,761 | 431 | 483 | 305 | 305 | 2,790 | 4,157 | 996 | 1,282 | 13,570 | 15,666 |
| 2009 | 464 | 682 | 3,130 | 5,874 | 880 | 913 | 2,081 | 2,851 | 103 | 385 | 495 | 495 | 4,156 | 5,939 | 1,133 | 1,358 | 7,215 | 10,832 |
| 2010 | 659 | 828 | 4,635 | 6,431 | 828 | 861 | 2,599 | 2,941 | 319 | 793 | 382 | 382 | 4,022 | 6,032 | 3,497 | 3,704 | 14,531 | 18,802 |
| 2011 | 600 | 995 | 3,993 | 7,207 | 827 | 948 | 1,293 | 2,157 | 1,275 | 1,504 | 373 | 373 | 3,928 | 6,479 | 2,563 | 2,664 | 18,311 | 26,553 |
| 2012 | 731 | 845 | 3,181 | 6,416 | 915 | 1,055 | 1,937 | 3,015 | 401 | 620 | 764 | 764 | 3,993 | 5,392 | 959 | 959 | 10,341 | 12,081 |
| Goal | | | 3,000 | | 900 | | 1,200 | | | | 700 | | 2,500 | | | | | |

[1] Escapement excludes brood stock for supplementation program. Total run includes redd count based escapement, terminal catch, and adult brood stock collected for supplementation and Pacific Salmon Commission indicator program.

Appendix B.8.–Columbia River escapements and terminal runs (t. run) of Pacific Salmon Commission Chinook Technical Committee wild Chinook salmon escapement indicator stocks.

| Year | Columbia Upriver Springs[1] | | | | | | Columbia Upriver Summers[2] | | Lewis River Fall Chinook salmon[3] | | Columbia Upriver Fall Chinook salmon | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Upper Col. R. | | Snake R. Spr/Sum | | Total[1] | | | | | | Deschutes River[4] | | | Upriver brights[5] | |
| | Esc | t.run | Esc | t.run | Esc | t.run | Esc | t.run | Esc | t.run | Esc | Esc | t.run | Esc | t.run |
| | | | | | | | | | | | | Above | | | |
| 1975 | | | | | | | | | 13,859 | 13,859 | Mark | Falls | | 29,600 | 163,833 |
| 1976 | | | | | | | | | 3,371 | 3,371 | Recapture | Expanded | | 27,700 | 109,076 |
| 1977 | | | | | | | | | 6,930 | 6,930 | | 7,903 | 9,764 | 36,060 | 85,336 |
| 1978 | | | | | | | | | 5,363 | 5,363 | | 5,393 | 7,364 | 25,798 | 77,936 |
| 1979 | | | | | | | 18,797 | 22,142 | 8,023 | 8,023 | | 5,126 | 6,718 | 28,926 | 82,482 |
| 1980 | 2,772 | 7,128 | 6,134 | 20,968 | 8,906 | 28,096 | 13,854 | 22,498 | 16,394 | 16,856 | | 4,106 | 6,057 | 27,708 | 70,743 |
| 1981 | 3,253 | 6,056 | 11,318 | 24,774 | 14,571 | 30,830 | 8,639 | 18,746 | 19,297 | 20,298 | | 6,070 | 7,907 | 19,520 | 58,693 |
| 1982 | 3,015 | 6,328 | 11,307 | 27,628 | 14,322 | 33,956 | 6,587 | 14,369 | 8,370 | 10,126 | | 5,513 | 7,529 | 28,313 | 71,471 |
| 1983 | 4,286 | 7,299 | 9,845 | 20,948 | 14,131 | 28,247 | 6,334 | 13,145 | 13,540 | 14,489 | | 5,491 | 6,987 | 45,567 | 79,113 |
| 1984 | 4,608 | 6,725 | 7,929 | 14,126 | 12,537 | 20,851 | 13,984 | 18,765 | 7,132 | 8,128 | | 2,779 | 3,749 | 52,266 | 127,651 |
| 1985 | 8,941 | 10,311 | 10,682 | 14,866 | 19,623 | 25,177 | 14,505 | 18,522 | 7,491 | 8,241 | | 7,902 | 8,709 | 74,206 | 187,691 |
| 1986 | 5,519 | 7,931 | 11,359 | 20,096 | 16,878 | 28,027 | 14,850 | 18,752 | 11,983 | 13,504 | | 7,467 | 8,620 | 93,051 | 272,949 |
| 1987 | 6,352 | 8,783 | 10,140 | 15,874 | 16,492 | 24,657 | 13,415 | 22,715 | 12,935 | 14,173 | | 9,187 | 11,244 | 126,153 | 409,412 |
| 1988 | 5,658 | 7,507 | 11,182 | 17,369 | 16,840 | 24,876 | 13,634 | 22,720 | 12,059 | 13,636 | | 9,548 | 11,939 | 98,220 | 327,976 |
| 1989 | 4,130 | 7,476 | 6,499 | 14,722 | 10,629 | 22,198 | 17,484 | 22,201 | 21,199 | 22,813 | | 6,339 | 8,069 | 83,281 | 253,233 |
| 1990 | 2,808 | 4,446 | 9,357 | 17,596 | 12,165 | 22,042 | 13,432 | 18,794 | 17,506 | 18,784 | | 2,864 | 3,834 | 49,020 | 149,759 |
| 1991 | 1,533 | 2,442 | 5,756 | 13,115 | 7,289 | 15,557 | 10,191 | 14,323 | 9,066 | 10,354 | | 5,374 | 5,528 | 40,132 | 97,758 |
| 1992 | 3,163 | 4,272 | 12,677 | 20,676 | 15,840 | 24,948 | 7,706 | 9,428 | 6,307 | 7,129 | | 3,668 | 3,705 | 41,434 | 77,311 |
| 1993 | 3,102 | 4,062 | 12,531 | 17,928 | 15,633 | 21,990 | 12,927 | 14,021 | 7,025 | 8,106 | | 8,809 | 8,820 | 42,515 | 94,088 |
| 1994 | 611 | 1,045 | 1,856 | 3,721 | 2,467 | 4,766 | 12,292 | 14,691 | 9,939 | 10,541 | | 9,556 | 9,625 | 66,645 | 123,214 |
| 1995 | 108 | 225 | 1,167 | 3,399 | 1,275 | 3,624 | 10,623 | 12,455 | 9,718 | 12,155 | | 9,304 | 9,340 | 50,595 | 97,119 |
| 1996 | 317 | 577 | 3,643 | 9,042 | 3,960 | 9,619 | 9,417 | 12,080 | 13,971 | 13,971 | | 10,233 | 10,311 | 53,049 | 132,882 |
| 1997 | 746 | 1,224 | 5,055 | 9,565 | 5,801 | 10,789 | 10,063 | 17,709 | 8,670 | 8,670 | | 20,208 | 20,341 | 50,215 | 141,386 |
| 1998 | 367 | 548 | 7,281 | 13,762 | 7,648 | 14,310 | 11,225 | 15,536 | 5,929 | 5,929 | | 15,908 | 16,415 | 42,113 | 125,886 |
| 1999 | 284 | 403 | 2,853 | 5,770 | 3,137 | 6,173 | 18,588 | 21,867 | 3,184 | 3,184 | | 7,389 | 7,762 | 43,313 | 158,044 |
| 2000 | 904 | 1,370 | 8,187 | 13,856 | 9,091 | 15,226 | 20,218 | 22,595 | 9,820 | 9,820 | | 4,985 | 5,392 | 60,988 | 150,352 |

–continued–

Appendix B.8. Page 2 of 2.

| Year | Columbia Upriver Springs[1] | | | | | | Columbia Upriver Summers[2] | | Lewis River Fall Chinook salmon[3] | | Columbia Upriver Fall Chinook salmon | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Upper Col. R. | | Snake R. Spr/Sum | | Total[1] | | | | | | Deschutes River[4] | | | Upriver brights[5] | |
| | Esc | t.run | Esc | t.run | Esc | t.run | Esc | t.run | Esc | t.run | Esc | Esc | t.run | Esc | t.run |
| 2001 | 4,807 | 6,263 | 44,572 | 63,401 | 49,379 | 69,664 | 48,844 | 52,960 | 13,886 | 14,186 | 9,527 | 12,817 | 9,861 | 84,652 | 222,630 |
| 2002 | 1,957 | 2,995 | 29,872 | 52,746 | 31,829 | 55,741 | 86,825 | 89,524 | 16,380 | 18,230 | 11,133 | 11,907 | 12,125 | 116,858 | 265,144 |
| 2003 | 1,554 | 2,165 | 32,080 | 51,369 | 33,634 | 53,534 | 81,543 | 83,058 | 18,505 | 20,505 | 14,265 | 13,413 | 15,343 | 161,136 | 357,848 |
| 2004 | 1,638 | 2,305 | 20,967 | 33,498 | 22,605 | 35,803 | 62,311 | 65,623 | 15,342 | 17,133 | 10,197 | 10,197 | 11,421 | 149,529 | 356,437 |
| 2005 | 2,057 | 2,779 | 9,832 | 15,274 | 11,889 | 18,053 | 54,033 | 60,272 | 11,348 | 13,348 | 9,355 | 14,937 | 10,190 | 111,721 | 258,554 |
| 2006 | 920 | 1,441 | 9,340 | 16,820 | 10,260 | 18,261 | 61,821 | 77,573 | 10,522 | 11,999 | 14,196 | 14,223 | 14,981 | 76,722 | 215,407 |
| 2007 | 448 | 521 | 6,903 | 10,614 | 7,351 | 11,135 | 28,222 | 37,035 | 3,468 | 3,606 | 13,181 | 12,721 | 13,968 | 45,652 | 98,657 |
| 2008 | 694 | 856 | 17,171 | 24,040 | 17,865 | 24,896 | 38,171 | 55,532 | 5,200 | 5,200 | | 6,908 | 7,614 | 74,386 | 189,681 |
| 2009 | 1,089 | 1,089 | 14,313 | 20,399 | 15,402 | 21,488 | 44,295 | 53,881 | 5,410 | 5,760 | | 6,429 | 7,116 | 85,759 | 204,932 |
| 2010 | 2,399 | 3,017 | 25,211 | 34,934 | 27,610 | 37,951 | 47,220 | 72,346 | 8,701 | 8,701 | | 9,275 | 10,066 | 167,007 | 314,842 |
| 2011 | 1,649 | 2,020 | 23,844 | 30,684 | 25,493 | 32,704 | 44,432 | 80,574 | 8,009 | 11,025 | | 17,117 | 18,168 | 130,395 | 305,940 |
| 2012 | 3,738 | 4,763 | 24,828 | 33,723 | 28,566 | 38,486 | 52,184 | 58,300 | 8,143 | 8,450 | | 17,624 | 18,785 | 131,613 | 276,483 |
| Goal | | | | | | | 12,143 | | 5,700 | | | 4,532 | | 40,000 | |

[1] For the purposes of U.S. v. Oregon management and tribal treaty/non-treaty allocation, the Columbia Upriver spring stock includes all fish destined to pass Bonneville Dam during the spring management period, including those destined for major tributaries such as the Deschutes and John Day rivers. These estimates of river mouth return and escapement are for only the adult upper Columbia wild spring Chinook salmon and the adult Snake River wild spring/summer Chinook salmon components. Escapements are past Rock Island Dam and past Lower Granite Dam (plus Tucannon River escapement), respectively. These are reported annually by the U.S. v. Oregon Technical Advisory Committee (Joint Columbia River Management Staff 2013, Tables 8 and 9). Previously, escapements were obtained as the product of terminal run fish not subsequently caught, the percent destined for the upper Columbia, and percent destined to spawn naturally. The reporting methodology was changed for consistency, stability and simplicity, and should provide for adequate analysis of escapement trends for Columbia Upriver Springs overall.

[2] Based on a stock-recruitment analysis of model data which included both hatchery and wild fish, an interim goal of 12,143 adult Mid-Columbia summers at Rock Island Dam was developed. For consistency with the goal, the escapement time series reported here was changed to the total adult Rock Island Dam count. The terminal run is that reported for Upriver summer Chinook salmon in the Joint Staffs Reports as the Bonneville Dam Count plus catch in lower river fisheries. These were also changed to include both hatchery and wild returns, where previously only naturally spawning returns were reported.

[3] This is the number of naturally spawning adult fish in the Lewis River. The terminal run given is the escapement plus the Lewis River sport catch of wild adults.

[4] The first column gives the estimate based on a mark–recapture project for the entire river, which was used to verify the Sherars Falls estimates. The second column is the estimate based on using the ratio of redds above and below Sherars Falls. The time series of data through 2009 were updated based on a comprehensive analysis done by Warm Springs, ODFW and CRITFC staff (Sharma, R, J. Seals, J. Graham, E. Clemons, H. Yuen, M. McClure, K. Kostow, and S. Ellis. 2010. Deschutes River Chinook spawner escapement goal using U.S. v. Oregon Technical Advisory Committee data. Unpublished Report).

[5] The CRFMP (1988) stated an interim escapement goal of 40,000 natural spawning upriver brights at McNary Dam, including 38,700 for Hanford Reach and 1,100 Snake River. In 1990, the escapement goal was increased to 45,000 for increased hatchery programs. In 1994, a management goal of 46,000 was established, and in 1995, the management goal was retained while the escapement goal was reduced to 43,500. In 2002, the CRFMP (1988) escapement goal of 40,000 was agreed to by the Chinook Technical Committee. Escapement numbers given are McNary adult dam count minus adult sport and broodstock above the dam. The terminal run is the Columbia River mouth terminal run of upriver brights minus the Deschutes River fall Chinook salmon terminal run.

Appendix B.9.–Oregon Coastal escapements as estimated via traditional habitat expansion methods and terminal runs (t. run) of Pacific Salmon Commission Chinook Technical Committee wild Chinook salmon escapement indicator stocks.

| | **Oregon Coastal** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Nehalem R.** | | **Siletz R.** | | **Siuslaw R.** | | **Coquille R.** | |
| **Year** | **Esc** | **t. run** | **Esc** | **t. run** | **Esc** | **t. run** | **Esc** | **t. run** |
| 1975 | 5,197 | 5,303 | 2,062 | 2,689 | 4,427 | 4,548 | 4,927 | NA |
| 1976 | 9,807 | 9,908 | 1,326 | 2,036 | 7,999 | 8,153 | 2,188 | NA |
| 1977 | 11,478 | 12,093 | 3,314 | 3,919 | 9,492 | 10,362 | 4,379 | NA |
| 1978 | 12,059 | 12,244 | 2,062 | 3,700 | 5,872 | 6,879 | 3,951 | 5,290 |
| 1979 | 12,205 | 12,469 | 7,217 | 8,907 | 8,040 | 8,799 | 4,030 | 4,715 |
| 1980 | 5,555 | 5,832 | 3,680 | 4,820 | 10,630 | 11,183 | 4,014 | 4,622 |
| 1981 | 10,752 | 10,939 | 4,435 | 6,751 | 8,724 | 9,342 | 4,313 | 4,996 |
| 1982 | 5,085 | 5,282 | 3,415 | 4,514 | 10,870 | 11,774 | 6,249 | 6,865 |
| 1983 | 4,431 | 4,525 | 2,136 | 3,152 | 4,186 | 4,885 | 3,193 | 3,807 |
| 1984 | 20,341 | 21,623 | 3,461 | 4,552 | 11,168 | 12,437 | 4,502 | 5,164 |
| 1985 | 18,670 | 19,473 | 6,628 | 7,685 | 14,822 | 15,805 | 3,157 | 3,853 |
| 1986 | 10,389 | 11,920 | 6,748 | 7,799 | 14,844 | 15,965 | 4,470 | 5,125 |
| 1987 | 13,560 | 15,725 | 4,577 | 6,023 | 17,603 | 19,411 | 5,640 | 6,997 |
| 1988 | 14,889 | 17,185 | 7,805 | 9,257 | 41,746 | 44,380 | 7,451 | 8,635 |
| 1989 | 10,389 | 12,000 | 4,401 | 5,980 | 28,279 | 31,690 | 6,462 | 7,820 |
| 1990 | 5,104 | 6,789 | 4,313 | 5,373 | 26,799 | 29,593 | 6,064 | 7,567 |
| 1991 | 5,557 | 7,685 | 5,633 | 6,926 | 26,100 | 29,825 | 9,074 | 11,470 |
| 1992 | 9,060 | 11,863 | 6,044 | 7,460 | 26,090 | 28,350 | 13,293 | 15,911 |
| 1993 | 5,345 | 9,317 | 4,342 | 6,506 | 10,446 | 14,012 | 6,993 | 10,419 |
| 1994 | 6,486 | 9,412 | 10,475 | 12,188 | 23,570 | 25,890 | 6,698 | 8,696 |
| 1995 | 5,194 | 8,845 | 5,164 | 8,045 | 26,715 | 31,194 | 7,885 | 10,374 |
| 1996 | 9,211 | 13,285 | 7,394 | 10,274 | 33,051 | 39,705 | 6,346 | 8,790 |
| 1997 | 10,026 | 13,069 | 3,726 | 6,165 | 22,305 | 27,516 | 6,743 | 8,338 |
| 1998 | 8,245 | 10,869 | 5,516 | 7,175 | 24,708 | 28,882 | 9,930 | 12,680 |
| 1999 | 8,063 | 10,632 | 4,166 | 6,232 | 23,963 | 27,271 | 8,513 | 10,950 |
| 2000 | 6,855 | 9,119 | 6,787 | 9,462 | 15,730 | 19,588 | 6,684 | 8,974 |
| 2001 | 11,662 | 15,998 | 10,563 | 14,704 | 38,717 | 43,836 | 8,233 | 12,007 |
| 2002 | 18,089 | 22,657 | 14,054 | 19,019 | 41,058 | 47,905 | 11,848 | 15,578 |
| 2003 | 10,906 | 15,095 | 11,149 | 15,693 | 58,998 | 66,246 | 16,482 | 21,572 |
| 2004 | 9,975 | 14,792 | 3,902 | 10,419 | 40,033 | 46,062 | 11,346 | 14,041 |
| 2005 | 8,114 | 9,535 | 6,631 | 8,931 | 17,618 | 19,301 | 5,029 | 5,767 |
| 2006 | 4,711 | 5,902 | 4,108 | 6,194 | 28,082 | 29,926 | 3,009 | 3,790 |
| 2007 | 4,304 | 5,759 | 528 | 1,536 | 6,764 | 9,665 | 2,098 | 3,557 |
| 2008 | 3,810 | 4,865 | 1,202 | 1,682 | 11,119 | 12,405 | 4,562 | 5,813 |
| 2009 | 4,070 | 4,070 | 2,905 | 3,343 | 14,094 | 15,881 | 12,308 | 13,530 |
| 2010 | 5,384 | 7,254 | 4,225 | 5,118 | 22,197 | 25,846 | 32,318 | 36,940 |
| 2011 | 7,665 | 9,780 | 3,638 | 5,861 | 30,713 | 36,546 | 16,745 | 21,151 |
| 2012 | 7,515 | 10,068 | 4,871 | 6,657 | 20,018 | NA | 9,300 | NA |
| Goal | 6,989 | | 2,944 | | 12,925 | | pending | |

Appendix B.10.–Oregon Coastal escapements and terminal runs (t. run) as estimated by mark–recapture calibrated indexes of Pacific Salmon Commission Chinook Technical Committee wild Chinook salmon escapement indicator stocks. Those estimates presented in boldface represent estimates generated from direct mark–recapture study.

| | Oregon Coastal | | | | | | |
|---|---|---|---|---|---|---|---|
| | Nehalem R. | | Siuslaw R. | | Umpqua R. S. Fork | Coquille R. | |
| Year | Esc | t. run | Esc | t. run | Esc[1] | Esc | t. run |
| 1975 | 4,954 | 5,060 | 2,567 | 2,567 | NA | 6,668 | NA |
| 1976 | 9,345 | 9,446 | 4,565 | 4,565 | NA | 2,766 | NA |
| 1977 | 10,937 | 11,552 | 4,531 | 4,531 | NA | 5,676 | NA |
| 1978 | 11,491 | 11,676 | 2,867 | 3,874 | 400 | 5,618 | 6,957 |
| 1979 | 11,794 | 12,058 | 3,554 | 4,313 | NA | 5,203 | 5,888 |
| 1980 | 5,368 | 5,645 | 5,483 | 6,036 | 697 | 5,952 | 6,560 |
| 1981 | 10,390 | 10,577 | 3,767 | 4,385 | 890 | 6,405 | 7,088 |
| 1982 | 4,914 | 5,111 | 5,094 | 5,998 | 1,011 | 8,885 | 9,501 |
| 1983 | 4,282 | 4,376 | 923 | 1,622 | 1,628 | 4,686 | 5,300 |
| 1984 | 19,657 | 20,939 | 3,384 | 4,653 | 2,594 | 6,229 | 6,891 |
| 1985 | 18,042 | 18,845 | 6,845 | 7,828 | 2,246 | 4,498 | 5,194 |
| 1986 | 10,039 | 11,570 | 6,513 | 7,634 | 1,573 | 5,642 | 6,297 |
| 1987 | 13,103 | 15,268 | 5,568 | 7,376 | 2,795 | 6,429 | 7,786 |
| 1988 | 14,388 | 16,684 | 14,935 | 17,569 | 3,778 | 8,389 | 9,573 |
| 1989 | 10,039 | 11,650 | 12,856 | 16,267 | 6,162 | 6,948 | 8,306 |
| 1990 | 4,932 | 6,617 | 13,662 | 16,456 | 3,761 | 7,738 | 9,241 |
| 1991 | 5,370 | 7,498 | 15,709 | 19,434 | 6,717 | 10,508 | 12,904 |
| 1992 | 8,755 | 11,558 | 13,221 | 15,481 | 8,149 | 16,636 | 19,254 |
| 1993 | 5,165 | 9,137 | 2,960 | 6,526 | 3,364 | 7,446 | 10,872 |
| 1994 | 6,268 | 9,194 | 9,477 | 11,797 | 7,128 | 6,866 | 8,864 |
| 1995 | 5,020 | 8,671 | 10,246 | 14,725 | 11,388 | 12,060 | 14,549 |
| 1996 | 8,901 | 12,975 | 15,788 | 22,442 | 10,019 | 7,618 | 10,062 |
| 1997 | 9,689 | 12,732 | 8,313 | 13,524 | 7,286 | 8,580 | 10,175 |
| 1998 | 7,967 | 10,591 | 5,456 | 9,630 | 1,104 | 11,877 | 14,627 |
| 1999 | 7,792 | 10,361 | 11,785 | 15,093 | 1,804 | 10,653 | 13,090 |
| 2000 | **11,568** | **13,832** | 4,648 | 8,506 | 3,140 | 7,880 | 10,170 |
| 2001 | **12,431** | **16,767** | 16,814 | 21,933 | 6,510 | **12,512** | **16,286** |
| 2002 | **19,956** | **24,524** | **22,506** | **29,353** | 3,831 | **13,675** | **17,405** |
| 2003 | **24,196** | **28,385** | **28,801** | **36,050** | 8,918 | **18,876** | **23,966** |
| 2004 | 9,639 | 14,456 | **29,119** | **35,148** | 7,487 | **11,668** | **14,363** |
| 2005 | 6,801 | 8,222 | **14,884** | **18,813** | 3,084 | 5,438 | 6,176 |
| 2006 | 11,938 | 13,129 | 11,815 | 14,850 | 2,396 | 7,438 | 8,219 |
| 2007 | 5,193 | 6,648 | 3,920 | 6,821 | 2,457 | 2,098 | 4,037 |
| 2008 | 4,596 | 5,651 | 4,544 | 5,830 | 2,333 | 5,803 | 7,661 |
| 2009 | **5,332** | **5,440** | 5,237 | 7,024 | 3,014 | 15,653 | 16,875 |
| 2010 | 7,250 | **9,120** | 11,165 | 14,813 | 6,184 | 41,104 | 45,726 |
| 2011 | **11,143** | **13,258** | 11,909 | 17,742 | 7,550 | 21,291 | 25,697 |
| 2012 | **12,952** | **15,505** | 16,023 | NA | 5,635 | 11,828 | NA |
| Goal | pending | | pending | | pending | pending | |

[1] Preliminary analysis has shown that terminal catch of South Fork Umpqua River fall Chinook salmon is negligible.

# APPENDIX C. SENTINEL STOCKS PROGRAM IN 2012

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The Sentinal Stocks Committee (SSC) of the Sentinel Stocks Program (SSP) met in Seattle during December 2011 to review progress for projects funded in 2011 and to develop a request for proposals for projects in 2012. In response, the SSC was provided with 17 proposals for work in 2012. The SSC met in Vancouver from 29 January through February 1, 2012 to review proposals and 14 of the 17 submitted proposals were recommended for SSP funding in 2012. In February 2012, the PSC approved funding for all 14 proposals. The proposals were chosen as per the approach outlined in the directive from the Commission to the SSC entitled *Implementation Approach for the Chinook Sentinel Stocks Program, October, 2008* and the *Sentinel Stocks Program Second Stage Proposal Evaluation, February, 2009*. Recommended proposals represented stocks in all five regions specified in the directive (North Oregon Coast, Puget Sound, Fraser River, west coast of Vancouver Island, and NBC). The stocks recommended for study in the SSP are of significant importance to the management of fisheries for Chinook salmon under the PST. Final funded projects and budget amounts for the 2012 SSP are summarized in Appendix Table C.1. Summaries of results from these funded projects are provided in the narratives below.

*Table C.1.–Projects and funding levels for the SSP in 2012.*

| Stock Group | Stock | Title | 2012 Funding |
|---|---|---|---|
| Oregon Coast | Nehalem River | Nehalem R. Chinook Escapement Enumeration | $301,100 |
| Oregon Coast | Siletz River | Siletz River Chinook Escapement Enumeration | $228,900 |
| Puget Sound | Green River | Abundance Estimate for Green River Chinook | $141,900 |
| Puget Sound | Stillaguamish River | Abundance Estimate for Stillaguamish Chinook | $71,500 |
| Puget Sound | Snohomish River | Abundance Estimate for Snohomish Chinook | $217,800 |
| WCVI | Burman River | Burman River Chinook Escapement Estimation | $176,100 |
| WCVI | Multiple | Marble, Tahsis & Leiner Survey Life | $219,000 |
| WCVI | WCVI rivers | Statistical Framework | $30,000 |
| Fraser | S. Thompson River | Abundance Estimate S. Thompson Aggregate | $160,800 |
| Fraser | Chilko River | Chilko River Chinook mark–recapture | $224,000 |
| Fraser | Harrison Rover | Harrison Radiotelemetry | $51,100 |
| NBC | Nass River | Estimate of Aggregate Population in Upper Nass | $108,600 |
| NBC | Skeena River | Escapement Estimation of Skeena River w/ GSI | $35,800 |
| NBC | Skeena River | Retrospective Escapements of Skeena R. w/ GSI | $191,000 |

*Note:* Refer to List of Acronyms for definitions.

## C.1. Nehalem and Siletz River Chinook Salmon Escapement Enumerations in 2012

The Siletz and Nehalem populations of fall Chinook salmon are part of the NOC aggregate. The Nehalem basin is located at the far north of the NOC aggregate, while the Siletz basin is located approximately midway within the NOC aggregate of stocks. The NOC aggregate has historically been a very productive, resilient stock complex; however failures to reach escapement goals in the late 2000s prompted the need to better quantify performance of this group. The prior 10-year average (2002–2011) of adult spawning escapement of Chinook salmon in the Siletz River was 5,201 individuals. In the Nehalem River, the prior 10-year average (2002–2011) was 7,686 adult Chinook salmon.

Under the SSP, the ODFW estimated spawning escapement using standard mark–recapture methods. Adult fish were captured upon return to each basin using tangle nets in both basins. A modified fish ladder was also used in the Nehalem River. The ODFW marked fish using operculum punches, the location of which was varied to represent different time frames of freshwater entry. The second capture event(s) (recovery) occurred on the spawning grounds. ODFW examined carcasses for marks and collected biological data from carcasses when possible (e.g., MEPS length, sex, scales, and other marks). In 2012, a mark–recapture study on the North Fork Nehalem River was also implemented. The mouth of the North Fork is downstream of the usual marking location on the mainstem (South Fork) Nehalem. The ODFW captured and marked Chinook salmon in the North Fork using tangle nets and rod and reel. Recapture events included both spawning ground surveys and ongoing trapping activities at Waterhouse Falls near the NF Nehalem Hatchery.

The ODFW evaluated the likelihood that mark–recapture assumptions were violated using chi-square analyses and Stratified Population Analysis System (SPAS). Then, depending on the results of these tests and the data collected, the ODFW applied the best (least biased and most precise) estimation techniques for the data. The ODFW estimated population size from mark–recapture data in the Nehalem basin using the Chapman version of the Petersen equation. The ODFW used a stratified estimator (Darroch maximum likelihood, SPAS software) to derive a total estimate for the Siletz basin. The Siletz strata were chosen to represent differences in terms of timing of freshwater entrance and carcass recovery rates. The ODFW also conducted tests for size bias using cumulative size distributions and Kolmogorov-Smirnov tests for adult Chinook salmon. These tests suggested possible biases at our initial sampling events; therefore, the age and sex composition data from the recovery events were used to apportion the final estimates. The ODFW conducted creel surveys in both the Siletz and Nehalem basins. The intent of the creel surveys was to adjust escapement estimates accordingly to account for harvest above marking sites and to generate timely and robust estimates of terminal harvests.

The ODFW estimates escapement in Oregon coastal basins using habitat-expansion methodology in addition to mark–recapture estimations. Standardized spawning ground surveys are conducted to record live and dead counts of Chinook salmon. The largest daily sum of live and dead counts for a given survey location (the peak count) is identified, and an index calculated (number of fish per mile). The index is expanded by the total estimated available spawning habitat in each basin (in miles). The ODFW applies additional functions to adjust for likely observation error and non-random bias. Agency personnel have calculated estimates using these traditional methods while concurrently conducting mark–recapture experiments in the Siletz basin since 2005 (Table C.2) and in the Nehalem basin from 2000 to 2003 and from 2009 to 2012 (Table C.3).

*Table C.2.–Siletz River: Comparisons of Chinook salmon escapement estimates between traditional, habitat expansion methods and mark–recapture techniques with associated coefficient of variation.*

| Run Year | Traditional Estimate | Standard Survey Index (fish/mile) | Mark–Recapture Estimate | CV of Mark–Recapture Estimate |
|---|---|---|---|---|
| 2005 | 6,426 | 48 | 14,355 | 63% |
| 2006 | 4,108 | 30 | 15,891 | 21% |
| 2007 | 528 | 4 | 2,625 | 16% |
| 2008 | 1,203 | 9 | 1,202 | 20% |
| 2009 | 2,905 | 21 | 2,213 | 12% |
| 2010 | 4,225 | 31 | 10,985 | 43% |
| 2011 | 3,638 | 26 | 4,985 | 7% |
| 2012 | 4,871 | 35 | 8,738[1] | 19% |

[1] Value reflects a stratified Darroch estimation, additional analyses required to assess the influence of potential biases on the accuracy of the estimate.

*Table C.3.–Nehalem River: Comparisons of Chinook salmon escapement estimates between traditional, habitat expansion methods and mark–recapture techniques with associated coefficient of variation.*

| Run Year | Traditional Estimate | Standard Survey Index (fish/mile) | Mark–Recapture Estimate | CV of Mark–Recapture Estimate |
|---|---|---|---|---|
| 2000 | 6,855 | 56 | 10,678 | 26% |
| 2001 | 11,662 | 96 | 12,431 | 12% |
| 2002 | 18,089 | 112 | 19,956 | 5% |
| 2003 | 10,906 | 87 | 21,283 | 22% |
| 2009 | 5,390 | 34 | 5,786 | 18% |
| 2010 | 5,384 | 34 | 7,097 | 12% |
| 2011 | 7,665 | 49 | 11,084 | 14% |
| 2012 | 7,515 | 48 | 12,952 | 19% |

In 2012, the ODFW marked a total of 351 adult Chinook salmon in the Siletz River basin. A total of 1,290 adult carcasses were recovered on the spawning grounds; 58 of which were marked (~17% recovery rate). The escapement was estimated to be 8,994 (SE = 1,465) Chinook salmon using the stratified Darroch maximum likelihood estimator (2 × 2 matrix). The CV is 16%. The 2012 terminal in-river regulations allowed for angling above the marking site. Harvest above the marking site was estimated to be 256 adults (SE = 211), and reduced the spawning escapement estimate to 8,738 Chinook salmon adults. The SEs from the harvest and mark–recapture estimate were added to provide an overall SE estimate of 1,676 and a CV of 19%.

In 2012, the ODFW marked a total of 674 adult Chinook salmon in the Nehalem River. A total of 503 adult carcasses were recovered on the spawning grounds; 25 of which were marked (~4% recovery rate). Assumption testing supported the use of the pooled estimator which produced an estimate of 13,084 (SE = 2,405, CV = 18%) adult Chinook salmon. After adjusting for the area-specific harvest above the marking site (132 fish, SE = 69), an estimate of 12,952 (SE = 2,474, CV = 19%) adult Chinook salmon spawning in the river was developed. The CV of the estimate is above the CTC standard of 15%. In 2012, earlier high water occurred in the Nehalem River during what was likely the peak spawning time for the upper basin summer run fish. A low recovery rate of early returning fish occurred, likely contributing to the higher than desired CV.

Two ODFW crew members were dedicated to a mark–recapture study on the north fork. They marked a total of 27 adult Chinook salmon. During the second event, they examined 140 fish, of which 5 were recaptures (~19% recovery rate). A pooled Petersen estimate of 657 adult Chinook salmon was developed (SE = 216, CV = 33%). A fishery took place in the north fork above the marking site that harvested 78 Chinook salmon. Therefore, it was estimated that 579 adult Chinook salmon spawned in the north fork in 2012.

Previous studies in the Siuslaw, Umpqua, Coos, Coquille and Salmon rivers explored the use of a visual index gathered from the spawning ground surveys to represent accurate and relatively precise estimates of spawner abundance for Chinook salmon. Various survey indices, including but not limited to peak, live AUC, redds, and sum of dead counts were calibrated to mark–recapture derived escapement estimates to determine which index best represents true abundance over a period of years. Results from these studies suggest that peak counts are the most consistent indicator of abundance. These studies indicate that the indices derived using counts from both mainstem and tributary habitat correlated best. Given future and current constraints around personnel and funding resources, this research has focused on identifying surveys from both mainstem and tributary reaches where peak counts or other indices are most likely to adequately track abundance.

Preliminary calibration analysis of spawning ground surveys and mark–recapture experiments from the Nehalem and the Siletz river basins have been conducted. Values presented as calibration value represent the visual index divided by the mark–recapture estimate. The ideal conversion factor would have an inter-annual CV of zero if it tracks perfectly with changes in spawner abundance (Tables C.4 and C.5). Variability in the inter-annual CV is likely underestimated as this descriptive statistic does not incorporate the precision of the population estimate used, nor does it incorporate the variability within the survey index.

Results from standard survey calibration efforts using peak counts in the Nehalem River basin suggest a relatively strong relationship (CV = 24%; see Table C.4). Bias detected in some of the mark–recapture estimates may exclude these abundance estimates from the calibration analysis, thus additional studies may be necessary to improve confidence in the index relationship. Additional years of data in the North Fork Nehalem River are needed.

*Table C.4.–Calibration of index values from Chinook salmon (>600 mm) encountered on standard spawning ground surveys to mark–recapture estimates in the Nehalem River basin.*

| Run Year | Traditional Estimate | Mark–Recapture Estimate | CV of Mark–Recapture Estimate | Index (fish/mile) | Calibration Value (fish/mile) |
|---|---|---|---|---|---|
| 2000 | 6,855 | 10,678 | 26% | 56.0 | 0.00524 |
| 2001 | 11,662 | 12,431 | 12% | 95.8 | 0.00770 |
| 2002 | 18,089 | 19,956 | 5% | 112.3 | 0.00563 |
| 2003 | 10,906 | 21,283 | 22% | 86.5 | 0.00406 |
| 2009 | 4,070 | 5,786 | 18$ | 29.1 | 0.00503 |
| 2010 | 5,384 | 7,097 | 12% | 31.0 | 0.00436 |
| 2011 | 7,665 | 11,084 | 14% | 46.1 | 0.00416 |
| | | **Calibrated Index CV** | | | **24.4%** |

*Note: The index value is an annual average from four surveys totaling 3.5 miles. The calibrated index CV represents the variation around the calibration value over the seven years of study. The fish/mile index represents the average from all surveys of the maximum sum of live and dead Chinook salmon encountered on a given day.*

*Table C.5.–Calibration of two index values from Chinook salmon (>600 mm) encountered on select spawning ground surveys to mark–recapture estimates in the Siletz basin.*

| Run Year | Traditional Estimate | Mark–Recapture Estimate | CV of Mark–Recapture Estimate | Index (fish/mile) | Calibration Value (fish/mile) |
|---|---|---|---|---|---|
| 2005 | 6,426 | 14,355 | 63% | 84 | 0.00585 |
| 2006 | 4,108 | 15,891 | 21% | 131 | 0.00824 |
| 2007 | 528 | 2,625 | 16% | 26 | 0.00990 |
| 2008 | 1,203 | 1,202 | 20% | 16 | 0.01331 |
| 2009 | 2,905 | 2,213 | 12% | 24 | 0.01085 |
| 2010 | 4,225 | 10,985 | 43% | 42 | 0.00382 |
| 2011 | 3,638 | 4,985 | 7% | 48 | 0.00963 |
| | | **Calibrated Index CV** | | | **36.0%** |

*Note: The calibrated index CV represents the variation around the calibration value over the seven years of study. The fish/mile index represents the average from all surveys of the maximum sum of live and dead Chinook salmon encountered on a given day.*

The relationship of visual indices from Siletz River standard surveys have not correlated well with the mark–recapture estimates. The ODFW hypothesizes that one reason for this poor relationship is that the standard surveys in the Siletz River represent smaller, tributary type habitat which is not typically productive Chinook salmon habitat. In basins where the relationship between the standard surveys and the mark–recapture estimate is strong (i.e. Siuslaw and Salmon rivers), the standard surveys occur in habitats more typical of Chinook salmon spawning habitat. All of the standard surveys in the Siletz River are located in small tributary reaches, and this may explain the poor calibration results. The ODFW has identified some select mainstem surveys in the Siletz River basin where a visual index of abundance used in conjunction with tributaries appears to track abundance far better than the standard surveys. A peak count index and the sum of dead index from three surveys totaling 3.2 miles appear to be relatively good indicator of abundance in the basin (Table C.4).

The ODFW intends to identify a cost effective spawning ground survey design in which one or more of the measured metrics accurately and precisely represents Chinook salmon spawner abundance for the basin within the data standards developed by the CTC. The ODFW believes they can identify survey reaches in which Chinook salmon counts will more consistently track the spawner estimate derived through the mark–recapture methods across a range of run sizes and environmental conditions. The ODFW intends to survey such select mainstem and/or large tributary reaches annually throughout the duration of these studies. Such analysis will require multiple years of statistically sound mark–recapture experiments before a complete assessment of survey results can be performed with acceptable levels of certainty. The ODFW is also exploring a weighted least squares regression approach to determine the relationship between visual indices and the mark–recapture estimates of abundance. This technique may allow researchers to include study years where abundance estimates did not meet the precision standards necessary for the calibration approach. Using this approach, annual spawner escapement could be estimated from the regression equation and confidence bounds derived using peak count data.

## C.2. Abundance Estimate for Green River Chinook Salmon in 2011

The Green River summer/fall Chinook salmon population is one of five Chinook salmon stocks in Puget Sound used by the CTC as an escapement indicator for Puget Sound Natural Summer/Fall Fingerlings. Escapement indicator stocks monitor the effectiveness of the management regimes and, if necessary, their status may trigger additional management actions in AABM and ISBM fisheries. Based on red count surveys, the 2000 to 2009 average estimated escapement in the Green River was 6,118 Chinook salmon.

The WDFW estimated the abundance of Chinook salmon spawning in the Green River using GMR abundance estimates. Spawning adults were marked by obtaining a DNA microsatellite profiles from tissues sampled from adult carcasses (first sampling event). Marks were later recaptured by sampling out-migrating smolt offspring (second sampling event) and genetically identifying some fraction of marks as parents of some out-migrating offspring. Tissues from 382 Chinook salmon adult carcasses were collected in fall 2011. Tissues from 2,548 migrating smolt offspring of adults that spawned in fall 2011 were collected in spring of 2012 at a smolt trap in the Green River, upstream of the mouth of Soos Creek. Adults and a representative sub-sample ($n$ = 1,996) of juveniles were genotyped at 14 microsatellite DNA loci. Using the likelihood algorithms found in the software COLONY[1] the genetic data were used to match parents to offspring, inferring recaptures. The counts of marks, captures (genotyped juveniles × 2), and recaptures were then used in a pooled Petersen mark–recapture estimate of spawner abundance based on binomial sampling. The algorithms employed by COLONY also infer unsampled parents allowing enumeration of unique captures and unique recaptures. These were used in a pooled Petersen mark–recapture estimate of spawner abundance based on hypergeometric sampling and in a rarefaction curve estimate of the number of successful breeders.

The WDFW obtained genotypes for 328 marks, 1,902 juveniles, and, through parentage analysis, 368 recaptures. Using these data, the WDFW obtained preliminary unadjusted estimates of the binomial model GMR estimate of Chinook salmon spawner abundance. The 2011 spawner abundance estimate for upstream of the smolt trap was 3,382 (95% CI = 3,055–3,710) Chinook salmon. Performance standards will be met with GMR for 2011 (CV = 4.9%). The preliminary GMR abundance estimate for upstream of the smolt trap was almost 3.5 times the 2011 estimate for the entire Green River made using redd counts (993), which was similar to patterns seen in the 2010 GMR abundance estimate and to estimates made using traditional mark–recapture methods made in 2000, 2001, and 2002. In the final report, the WDFW will adjust the escapement estimate for the few adipose intact hatchery juveniles that escaped from rearing facilities upstream of the smolt trap, expand estimates for the area below the smolt trap using a basin-wide redd survey conducted in October, provide a GMR estimate based on the hypergeometric model, and provide a rarefaction curve estimate of successful breeders.

## C.3. Abundance Estimate for Stillaguamish River Chinook Salmon in 2011

Stillaguamish River Chinook salmon are one of seven escapement indicator stocks in Puget Sound used by the CTC. Stillaguamish River Chinook salmon are of concern under the PST due to declines from historic levels, current low abundance and resultant limitations this imposes on fisheries management. In addition, this stock was identified as a sentinel stock in the latest PST.

The SSP funded a study design to estimate the Chinook salmon spawning escapement using a genetic mark–recapture technique in 2011 and this study design was continued in 2012. In the first sampling, carcasses were collected in 2011 and tissues taken during weekly spawning ground surveys. Collected tissues were genotyped. In the second sampling in 2012, juveniles were collected from a downstream migrant trap located below the spawning area and tissues were taken. These tissues were also genotyped. A total of 112 genotyped carcasses constituted the marks and a total of 246 juveniles assigned back to spawners using parentage analysis constituted the recaptures out of a total of 1,428 captured juveniles. Using the Lincoln-Petersen estimate, based on Bailey's binomial model, the WDFW estimated the 2011 spawner abundance to be 1,296 Chinook salmon (CV = 6%), which was slightly higher than the redd-based estimate of 1,017 Chinook salmon.

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[1] Fortran program developed by Jinliang Wang, and available for download from http://www.zsl.org/science/research-projects/software/colony,1154,AR.html (Accessed June 27, 2013).

Unmarked hatchery juveniles and yearling hatchery juveniles presented challenges to the GMR study design. If unmarked hatchery juveniles (juveniles leaving the hatchery upstream of the smolt trap with adipose fins intact) and yearling juveniles (juveniles leaving the system after a year, rather than after emergence) in the smolt samples are unaccounted for they would inflate abundance estimates since they increase capture numbers yet have no possible parents in the mark pool. The WDFW identified unmarked hatchery juveniles by assigning smolts to hatchery brood stocks for their respective brood years and removed them prior to analyses. The WDFW examined the data for putative yearlings by regressing smolt lengths on capture date and observing outlier smolts—smolts that were much longer that average smolt lengths for each time strata, but found no such outliers. Because there were no Chinook salmon yearlings and few unmarked hatchery fish, adjusting for hatchery juveniles resulted in a small change in the GMR estimate. The WDFW preliminary GMR result is corrected for unmarked hatchery juveniles.

## C.4. Abundance Estimate for Snohomish River Chinook Salmon in 2011

The Snohomish River basin is comprised of two Chinook salmon populations: the Skykomish River summer population (which includes Skykomish, mainstem Snohomish, and Pilchuck rivers) and the Snoqualmie River fall population. The combined Skykomish and Snoqualmie river populations comprise the Snohomish River Chinook salmon summer/fall management unit or stock, which is one of five in Puget Sound used by the CTC as an escapement indicator for Puget Sound natural summer/fall fingerlings. Escapement indicator stocks monitor the effectiveness of the management regimes and, if necessary, their status may trigger additional management actions in AABM and ISBM fisheries.

The WDFW estimated the abundance of Chinook salmon spawning in the Skykomish and Snoqualmie rivers using GMR abundance estimates. Spawning adults were marked by obtaining a DNA microsatellite profile from tissue sampled from adult carcasses (first sampling event). Marks were later recaptured by sampling out-migrating sub-yearling smolt offspring (second sampling event) and genetically identifying some fraction of marks as parents of some out-migrating offspring. Scales and other tissues were taken in the fall 2011 from 149 Chinook salmon adult carcasses (marks) found in the Skykomish River (and tributaries) and from 221 Chinook salmon adult carcasses found in the Snoqualmie River (and tributaries). In the spring of 2012, tissues were taken from 1,644 out-migrating sub-yearling offspring of natural-origin Chinook salmon (1,268 from the Skykomish River trap and 376 from the Snoqualmie River trap). All hatchery- and natural-origin adults sampled for scales, all natural-origin adults sampled for operculum and all natural-origin juveniles were genotyped at 14 microsatellite DNA loci. Using the likelihood algorithms found in the software COLONY, the genetic data were used to match parents to offspring inferring recaptures. The counts of marks, captures (genotyped juveniles × 2), and recaptures were then used in a pooled Petersen mark–recapture estimate of spawner abundance based on binomial sampling. The algorithms employed by COLONY also infer unsampled parents allowing enumeration of unique captures and unique recaptures. These were used in a pooled Petersen mark–recapture estimate of spawner abundance based on hyper-geometric sampling and in a rarefaction curve estimate of the number of successful breeders.

For Skykomish River estimates, there were genotypes for 87 adults, 1,122 juveniles, and, through parentage analysis, 27 recaptures. For Snoqualmie River estimates, there were genotypes for 136 adults, 332 juveniles, and, through parentage analysis, 23 recaptures. Using these counts, the WDFW obtained preliminary unadjusted estimates of the binomial model GMR estimate of Chinook spawner abundance for areas upstream of each smolt trap. The Skykomish River spawner abundance estimate for upstream of the smolt trap was 6,857 Chinook salmon (95% CI = 4,377–9,337). The Snoqualmie River spawner abundance estimate for upstream of the smolt trap was 3,542 Chinook salmon (95% CI = 2,180–4,903). Performance standards were not met with GMR for 2011 (CV >15% for both estimates) due to low juvenile trap efficiencies and few carcass recoveries from the spawning ground surveys. To increase the probability of meeting the precision standard, the intensity of spawning ground surveys was increased for brood year 2012.

GMR abundance estimates were more than 4.5 times the 2011 estimates made using redd counts (1,180 for the Skykomish River and 700 for the Snoqualmie River). These preliminary estimates cover only the spawning areas found upstream of the smolt traps in each basin. The reported CV may not be an accurate estimate of uncertainty, since all sources of uncertainty have not yet been accounted for in these preliminary estimates. In addition to accounting for all sources of uncertainty, in the final report, the WDFW will generate a hypergeometric model-based GMR abundance estimate and a rarefaction curve-based estimate of successful breeders.

## C.5. Abundance Estimate for Burman River Chinook Salmon in 2012

The Burman River Chinook salmon population belongs to the WCVI fall Chinook salmon aggregate, an important production group contributing to catches in AABM and ISBM fisheries. Since 2009, the abundance of ≥age-3 Chinook salmon that returned to the Burman River has been estimated with mark–recapture experiments. In 2012, Chinook salmon were captured and marked using a beach seine in the lower river staging area as a first event and carcasses were recovered as a second event. Biological samples were collected while marking, from hatchery brood collections, or during carcass recoveries. In 2012, Chinook salmon were marked with a dorsally visible uniquely numbered 80 pound monofilament-cored Floy tag[2] secured with a 'J' size metal sleeve, and a secondary mutilation mark. One hundred and thirteen fish were marked with radio tags. Fish were identified by sex, post-orbital hypural length was measured, and scales were collected for ageing. Otoliths were recovered from carcasses to determine origin.

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[2] Product names used in this publication are included for completeness but do not constitute product endorsement.

A total of 1,166 adult Chinook salmon (399 females and 767 males) were marked and 94 marked animals (31 females and 63 males) were encountered among 348 carcasses (156 females and 192 males) recovered between September 19 and November 7, 2012. The preliminary pooled Petersen estimate of >age-3 and older Chinook salmon (>500 mm) was 4,119 fish (SE = 406, CV = 9.9%). The CV of the 2012 estimate met the CTC data standard; CVs of estimates from 2009 to 2012 have averaged 13.4%. The sex stratified pooled Petersen estimates were 1,954 females (SE = 323, CV = 16.5%) and 2,165 males (SE = 246, CV = 11.4%). Complete mixing of females ($X^2 = 3.47$, df = 4, and $P = 0.50$) and males ($X^2 = 7.69$, df = 4, $P = 0.10$) and equal proportions among females ($X^2 = 2.27$, df = 3, $P = 0.52$) and males ($X^2 = 1.97$, df = 2, $P = 0.37$) suggested the temporally pooled Petersen estimates stratified by sex were appropriate estimators. Sex selectivity was not significant, although marked males (0.082) were recovered at a slightly higher rate than marked females (0.078) ($X^2 = 0.185$, df = 1, $P = 0.667$). Size bias was not evident as the cumulative percent length-frequency distributions were not different between all fish marked and all fish recovered in the carcass survey ($D_1 = 0.0357$, $P = 1.00$) and of all marked carcasses ($D_1 = 0.000$, $P = 1.000$). The hatchery program in 2012 removed 194 adults and 9 jacks for broodstock.

Chinook salmon escapement was also estimated using snorkel surveys and AUC methods. Visual observations of live radio marked and unmarked fish were made to estimate observation efficiency during 22 snorkel surveys. Survey life was estimated with radio tags and from visual tag depletion curves. Individual radio tags were intended to signal when a fish died by emitting an altered code 12 hours after motion of the fish had ceased. Many of the radio tags did not function as intended or operated in reverse with the inactive code preceding the active code signal. Fixed telemetry receivers sites were established at the lower and upper bounds of the spawning area. One-hundred and seven unique radiotagged fish were detected entering the snorkel survey study area. Two faulty radio tags (9.5%) that did not transmit any signals were recovered among 21 radio tags collected during carcass surveys. Eighty-two radio tags were detected during mobile telemetry surveys intended to identify the number of live radiotagged fish available for observation. Three radiotagged fish ascended above the normal survey area boundary. The stray rate was low, validating the critical closure assumption. After ascending 4 km up the Burman River one radiotagged Chinook salmon (<1%) left the Burman River and entered the Gold River. The lower receiver was overwhelmed with signals from September 22 to October 2 due to the high density of radiotagged fish present in Section 1 of the river. Mobile surveys during this period were used to detect entry of radiotagged fish. Entry time was estimated as the mid-point between mobile surveys if not detected at the lower fixed receiver site; and death times were mid-points between surveys less the 12 hour delay period if the radio tag operated properly. When single detections occurred survey life was calculated as the average times between the adjacent surveys times.

Survey life ($SL_{fixed}$) estimated using the lower receiver site and mobile (foot and raft) detections ranged from 0.1 to 15.7 days and averaged 5.0 days (SE = 4.1, $n = 108$). Observer efficiency measured with radio tags was variable but averaged 0.52 (SE = 0.41). When snorkel observations were adjusted for observer efficiency and plotted against time, the resulting preliminary AUC estimate of escapement was 21,538 fish days and the population estimate was 4,273 or 1.7% less than the closed population mark–recapture estimate. A maximum likelihood AUC estimate of escapement quantifying the associated uncertainty will be included in the final project report.

The ratio of males to females was 1.1:1.0 in 2012. Although ageing is not complete, a partial sample of 183 scales analyzed to date indicate proportions by age of 21.9% (SE = 3.06, $n$ = 183) age 2, 7.7% (SE = 1.96) age 3, 44.3% (SE = 3.67) age 4, and 26.2% (SE= 3.25%) age 5. Unmarked otoliths comprised 17 or 4.8% (SE = 0.011, $n$ = 350) of the origin samples (including three overgrinds). Hatchery origin remained high with 95.1% (SE=0.011, $n$ = 350) of otolith samples bearing thermal marks. Burman River hatchery fish dominated the marked sample (99.1% or 330) that included one Robertson Creek Hatchery and two Conuma late-release hatchery origin fish. Given the escapement estimate, the number of naturally produced fish was about 200 animals in 2012. Carcass recovery was enhanced in 2012 due to the prolonged low flows over most of the spawning in period.

## C.6. Marble River, Tahsis River, and Leiner River Chinook Salmon Study in 2012

This project was conducted on the Marble, Tahsis and Leiner rivers to estimate survey life of Chinook salmon entering survey areas and to estimate observer efficiency of swimmers counting fish as a means to improve AUC estimates of spawner abundance. These empirical data were used to develop improved AUC estimates of Chinook salmon spawner abundance while normative procedures were used to generate AUC estimates as provided to the CTC. Chinook salmon were radiotagged to estimate survey life and marked with highly visible external spaghetti tags for estimation of observer efficiency. River discharge and visibility data were collected to examine possible relationships between survey conditions and observer efficiency.

In the Tahsis Inlet, 269 Chinook salmon were tagged and 75 (27%) of them were later detected in the Tahsis or Leiner rivers. In Varney Bay, 114 Chinook salmon were tagged; at the mouth of the Marble River another 14 Chinook salmon were tagged, and 28 (21%) of them were later detected in the Marble River. Motion sensors with radio tags used in 2012 malfunctioned, compromising the ability to detect if the fish were alive or dead. Based on position and signal strength of tags over time, a determination was made when individual fish most likely died. For instance, if a tag was showing as dead but had moved upstream since the last survey, it was likely still alive, but if it had not moved or only moved downstream, it was likely dead. The certainty of each determination was then categorized as low, medium, or high based on the information used to make the determination. Survey life estimates based on tags detected entering and leaving the survey area by the fixed telemetry sites were considered highly certain. Survey life based on behavior was less certain, as lack of upsteam movement indicated death, but exact date of death was unknown.

The mean survey life of Chinook salmon was 25.4 days (SD = 15, *n* = 10) in the Tahsis River, 28.8 days (SD = 14, *n* = 38) in the Leiner River, and 27.4 days (SD = 14, *n* = 10) in the Marble River. Estimates of observer efficiency ranged from 33% to 100% in the Tahsis and Leiner rivers and from 13% to 100% in the Marble River. Preliminary analysis indicates a potential weak relationship between river conditions (horizontal visibility and rate of discharge) and observer efficiency (Figure C.1).

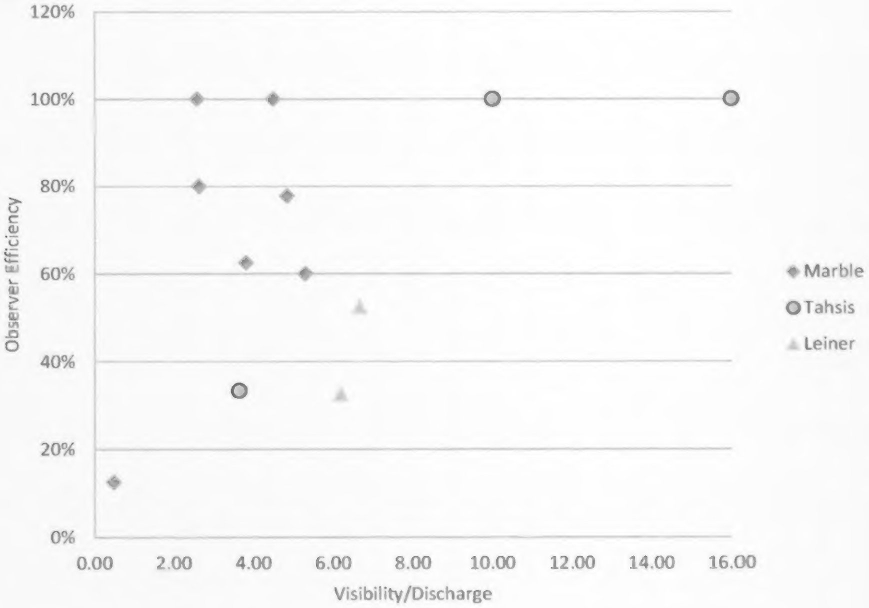

*Figure C.1.–Plot of observer efficiencies of swimmers surveying Chinook salmon abundance in the Marble, Tahsis, and Leiner rivers in 2012 versus measures of horizontal visibility divided by discharge.*

Estimates of survey life of Chinook salmon in the Marble, Tahsis, and Leiner rivers in 2012 were at the high end of values used for normative WCVI Chinook salmon AUC procedures; values typically used range from 15 to 25 days. Measured observer efficiency in 2012 was typically lower than the self-reported observer efficiency estimates as used in normative WCVI Chinook salmon AUC procedures. Self-reported observer efficiency estimates are rarely less than 80% and are usually 90% to 100%. Based on this study, surveyors appear to overestimate efficiency. Normative AUC estimates as provided to the CTC for the Marble, Tahsis, and Leiner rivers in 2012 are lower than AUC values that include measured survey life and observer efficiency (Table C.6).

*Table C.6.–Normative AUC estimates of abundance of Chinook salmon in 2012 in the Marble, Leiner, and Tahsis rivers versus estimates that include measured survey life and observer efficiency.*

| River | Normative AUC Estimates as Reported to CTC | AUC Estimates Using Measured Survey Life and Observer Efficiency |
|---|---|---|
| Marble | 2,364 | 2,509 (6% higher) |
| Leiner | 566 | 772 (36% higher) |
| Tahsis | 163 | 227 (39% higher) |

## C.7. West Coast Vancouver Island Statistical Framework to Assess Chinook Salmon Escapement

A Canadian Science Advisory Process workshop has been scheduled for June 2013. The goal of the workshop is to produce Chinook salmon escapement monitoring framework for the WCVI area.

## C.8. Abundance Estimates for South Thompson River Chinook Salmon

The Fraser summer run age-.3 stock group spawns in several locations, ranging from the Lower Fraser River area to the upper reaches of the South Thompson River watershed, and the stock group consists of two genetic reporting groups. The South Thompson genetic group represents fish originating from the Lower Thompson, South Thompson, Little, Lower Adams, Lower Shuswap and Middle Shuswap rivers. The South Thompson aggregate has a mean annual escapement of 95,000 (2001–2012) based on the peak count method, which involves counting spawners, holders, and carcasses or redds from low elevation, helicopter surveys. Three of these rivers are extremely large and can have poor conditions for visual counts, yet the visual surveys identified that large numbers of spawners use these systems. The indicator stock expansion methods developed in the mid-1980s were modified to estimate the escapement of the ocean-type component of the South Thompson genetic group. Furthermore, escapement estimates for individual populations can be generated from the stream-specific mark–recapture programs on the Middle and Lower Shuswap rivers, and the aggregate escapement to the remaining systems (with poor visual survey conditions) is estimated by subtracting the mark–recapture estimates from the total aggregate estimated by the indicator stock expansion method.

The modified indicator stock expansion method uses a Bayesian model that relies on genetic stock identification, scale age, and CWT data sampled from fisheries in Northern BC and at the mouth of the Fraser River, as well as CWT data sampled from the spawning grounds for the Lower Shuswap and Middle Shuswap exploitation rate indicator stocks. The SSP funded the estimation of South Thompson escapements from 2009 to 2012 and the Northern Endowment Fund supported the approach from 2004 to 2008.

For 2012, some of the genetic samples have not yet been analysed, so the results will be reported next year. The 2012 mark–recapture estimates for the Lower Shuswap was 4,091 (CV = 3%) Chinook salmon and for the Middle Shuswap was 293 (CV = 16%) Chinook salmon, both of which are the lowest escapements observed since the early 1980s. Due to the very low escapement to Middle Shuswap River, applying and recovering sufficient Petersen tags was very challenging; however, enough brood stock were collected to meet the target goal of applying 150,000 CWTs to juvenile Chinook salmon.

The indicator stock expansion method was used as an alternate escapement estimation method from 2004 to 2011. Since the late 1970s, escapements have been estimated mainly using the peak count method for these rivers (Table C.7). The development of escapement method calibration relationships has been ongoing for individual and aggregated populations within this stock group and results will be provided in December 2013.

*Table C.7.–Estimates of escapement for the South Thompson aggregate using the peak count method and the indicator stock expansion method.*

| Year | Estimate from Peak Count Method | Estimate from Indicator Stock Expansion Method | CV of Indicator Stock Expansion Method |
|---|---|---|---|
| 2004 | 61,550 | 155,688 | 22% |
| 2005 | 88,313 | 103,386 | 15% |
| 2006 | 149,883 | 212,667 | 17% |
| 2007 | 85,731 | 167,057 | 35% |
| 2008 | 106,539 | 160,058 | 15% |
| 2009 | 86,377 | 164,300 | 7% |
| 2010 | 157,289 | 213,200 | 11% |
| 2011 | 127,958 | 145,700 | 17% |
| 2012 | 47,949 | *Not Yet Available* | *Not Yet Available* |

## C.9. Abundance Estimate for Chilko River Chinook Salmon in 2012

The Chilko River has one of the largest returns of summer-run (age-1.3 stock group) Chinook salmon in the Fraser River watershed with a mean escapement of 9,000 fish (2001–2012) using the peak count method. The 2012 escapement of summer-run Chinook salmon to the Chilko River was estimated using a two-event mark–recapture study and the peak count method based on concurrent aerial visual surveys. Petersen tags and sex-specific secondary marks were applied to 680 adult Chinook salmon captured using a combination of seining and angling (one male was removed during the First Nation fishery). Recovery sampling was undertaken on carcasses, and 267 marked adults were recovered from a total recovery sample of 1,490 adult carcasses. The age composition of the recovery sample was 4% age 3, 35% age 4, 59% age 5, and 2% age 6. All samples showed a two-year freshwater growth pattern. Only two tags were applied to jacks, of which none were recovered. There were only four jacks sampled during carcass recovery; therefore, a valid estimate of the jack escapement could not be calculated.

The results of the bias testing indicated that measurable sources of stress including holding time, marking, number of times recaptured, and release condition did not have a significant impact on the subsequent behaviour of the marked fish. The mark–recapture assumption of closure was likely met based on the mark–recapture field observations, aerial survey data, and the 2010 radio telemetry study. There was no evidence of spatial bias in the application or recovery sample for both sexes. There was evidence of temporal bias in the application sample for females and in the recovery sample for both sexes. Due to these temporal biases, the SPAS was used for both sexes. The SPAS results confirmed that due to incomplete mixing there was a requirement to use the maximum likelihood Darroch method for females. However, due to equal proportions there was no requirement to use the maximum likelihood Darroch for males and the Petersen estimator was used. The 2012 adult spawning population estimate was 4,222 (CV = 6%) Chinook salmon with sex-specific escapement estimates of 2,181 males (CV = 10%) and 2,041 females (CV = 7%). The peak count estimate of adult escapement, based on the aerial survey data was 3,845, which is 9% less than the mark–recapture adult estimate. The measured peak count expansion factor was 1.10, using the peak count of 2,499 spawners, holders, and carcasses observed on September 12, 2012.

## C.10. Harrison River Radiotelemetry Study of Chinook Salmon in 2012

The Harrison River (fall age-.3 stock group) is the only river with naturally produced fall (late) run Chinook salmon in the lower Fraser watershed. From 1982 to present, the escapement has been estimated using high-precision, two-event mark–recapture methods with a mean annual escapement of 103,500 (2001–2011) adult spawners. In 2012, a telemetry study on Harrison River Chinook salmon was conducted to investigate the behaviour and distribution of the spawning population, and to determine whether this two-event mark–recapture study met the assumption of closure. Ninety-four radio tags were applied proportionally to male and female Chinook salmon throughout the mark–recapture tag application period, and were monitored throughout the mark–recapture study.

Telemetric monitoring results showed that after migrating into the Harrison River, Chinook salmon typically held upstream of the spawning areas before dropping back downstream to spawn. A few male and female radiotagged fish did move downstream of the spawning areas before moving back upstream to spawn. Spawning activity was concentrated in the Harrison Rapids, similar to previous observations.

All radiotagged Chinook salmon were tracked within the Harrison River, with the exception of one radio tag that failed directly after application and release. All radiotagged Chinook salmon remained within the Harrison River mark–recapture study area to spawn. No radiotagged Chinook salmon passed the upper boundary of the study area. Fourteen radiotagged fish passed the lower boundary of the study area, three of these were confirmed as carcasses downstream of the Harrison-Fraser confluence. It is likely that all of those radiotagged fish (14) that passed the lower extent of the study area were either moribund or recently dead, and very unlikely to have spawned elsewhere. No radiotagged Chinook salmon entered the Chilliwack River, a tributary of the Fraser River just downstream of the Harrison River with an introduced hatchery population of fall run Chinook salmon. Overall, the assumption of closure for the two-event mark–recapture for the Harrison River Chinook salmon was confirmed in 2012 based on the results of this telemetric study. For 2012, the spawning escapement based on the MR study was estimated to be 44,500 (CV = 9%) adult Chinook salmon.

## C.11. Abundance Estimate for Nass River Chinook Salmon in 2012

The Upper Nass River Chinook salmon aggregate stock (hereafter referred to as Nass Chinook salmon) is one of the CTC indicator stocks. It is a large stock group, comprising a single CDFO conservation unit, consisting of at least 10 separate populations spawning in the Nass River watershed, upstream of and including Tseax River, and has averaged 19,000 spawners from 1994 to 2011. Nass Chinook salmon are an important contributor to the Pacific Coast Chinook salmon resource and represent a very stable proportion of the Chinook salmon stocks caught in the AABM and ISBM fisheries in northern BC and Alaska. Nass Chinook salmon are a completely natural population with no history of enhancement and likely very little, if any, straying from other enhanced systems.

Since 1994, escapement estimates for Nass Chinook salmon have been derived using mark–recapture methodology. Adult Chinook salmon (≥50 cm nose to tail fork length) are marked at fish wheels operated on the Lower Nass River by applying numbered aluminum chick-wing tags to the left operculum. Live fish are subsequently examined for marks at the Meziadin Fishway and both live fish and carcasses are examined for marks in other Upper Nass River tributaries. Recovery locations have varied over the years but have normally included Damdochax Creek and Kwinageese River, which combined with Meziadin River represent approximately 40% of the Upper Nass Chinook salmon aggregate stock based on radio telemetry (1992–1993) and recent genetic (2007, 2010–2012) data.

From 1994 to 2008, Nass Chinook salmon mark–recapture estimates achieved coefficients of variation less than or equal to 15% in only 9 of 15 (60%) years. The main factor influencing the CV over this period was the number of marked Chinook salmon examined and recovered at terminal spawning areas in the Upper Nass River watershed. From 2009 to 2012 (years 1–4), the PSC has funded a Nass Chinook salmon mark–recapture project as part of the SSP to assist in achieving a more accurate and precise mark–recapture estimate. The funding received from the PSC in year 1 helped achieve the CTC CV standard by permitting sufficient tag-recovery efforts (CV = 13%). However, in year 2 a modest return combined with extreme low water, and therefore low Chinook salmon catchability at the Nass fish wheels, resulted in failure to achieve the standard (CV = 25%). In year 3, tagging at three Grease Harbour (GH) fish wheels in addition to GW fish wheels ensured that the CV standard was met despite a very low return (CV = 9%). Two key recommendations emerged from the first three years of the study, emphasizing the need to both apply and recover adequate marks: 1) to mark Chinook salmon at both the GW and GH fish wheels to ensure that at least 1,000 marks were applied to the aggregate population, and 2) to continue mark recovery operations at Meziadin Fishway, the Kwinageese weir, and Damdochax Creek to ensure adequate numbers of fish were examined and marks were recovered.

In 2012, the PSC funded Year 4 of the Nass Chinook salmon mark–recapture study. A total of 1,164 adult Chinook salmon were marked at two GW fish wheels and an additional 1,917 were marked at three GH fish wheels. The fish wheels operated from June 1 to September 15 with adult Chinook salmon captured and tagged from June 2 to August 28. A total of 3,081 marked Chinook salmon were released, and after accounting for removals by in-river fisheries and estimated tagging/handling related mortality (*n* = 532 censored), an estimated 2,549 marked fish were available for recovery in upstream tributaries. A total of 1,095 fish were examined for marks at mark–recapture sites of which 299 were marked from the fish wheels (overall mark rate = 27.3%).

Tests for size, sex, age, temporal, and spatial bias in capture and recovery samples were conducted in 2012. Unlike past years, a significantly lower mark rate at Meziadin Fishway was detected in this study when compared to the other recovery sites (chi-square $\chi^2$ = 20.96, df = 2, *P* = <0.001). However, genetic results did not suggest a bias in the fish wheel catches when compared to past stock composition estimates. Estimates could not be stratified by recovery location; only 76 of the 299 recoveries had tag data available as tag numbers could not be read at the Kwinageese video counting weir, which accounted for 75% (224) of the tag recoveries in 2012. For size selectivity bias tests, recovered fish were not significantly smaller than examined fish as a whole (Kolmogorov-Smirnov test; D = 0.070, *P* = 0.61) and the mark rate for medium (50–75.4 cm nose to tail fork length) Chinook salmon was not significantly higher than for large (≥75.5 cm nose to tail fork length) Chinook salmon at recovery locations (chi-square $\chi^2$ = 0.16, df = 1, *P* = 0.69). These results are different from years 1–3 and suggest that the higher water and ideal fish wheel fishing conditions during peak Chinook salmon migration in 2012 may have negated the differential ability of larger Chinook salmon to avoid capture by the fish wheels.

Despite the lack of evidence for size bias, to facilitate comparison with other years a size stratified adjusted Petersen population estimate for Nass Chinook salmon was calculated and presented alongside an estimate generated by pooling the size classes. Summing estimates of 1,829 (SE = 223; CV = 14.5%) medium and 7,166 (SE = 380; CV = 6.3%) large Chinook salmon spawning between GW and GH, or passing upstream of GH, produced an overall size stratified escapement estimate of 8,996 Chinook salmon (SE = 440; 95% C.I.: 8115–9876; CV = 5.8%). The stratified estimate was similar (~300 fish smaller) to the estimate generated by pooling size classes (9,315; SE = 458; 95% C.I.: 8321–10,429 CV = 5.8%). Subtracting the in-river harvests above GH (308) from the stratified overall escapement estimate yielded a net escapement estimate of 8,688 adult Chinook salmon above GW. Adding the harvest (2,097) of Chinook salmon from all fisheries above GW to the net escapement estimate yielded an estimate of the total return of adult Chinook salmon to GW in 2012 of 10,785. The 2012 return represented the second lowest return of Nass Chinook salmon since the start of the fish wheel program in 1994. Chinook salmon marked and successfully aged (*n* = 2,187) at the fish wheels in 2012 were: 69% age 5, 21% age 4, 8% age 6, and 1% age 3.

Handling and marking a significantly higher proportion of the Chinook salmon population than required to reach the CV standard is not desirable. The very high proportion of the population that was marked in 2012 was a consequence of atypically high catchability of Chinook salmon at the fish wheels during the peak migration period. Therefore, it is recommend that in future years marking of Chinook salmon continue to occur at both the GW and GH fish wheels; however, if 400 tags are applied at the GW fish wheels by June 23, it is recommend that marking at GH be limited to two fish wheels to reduce handling of fish. In addition, it is recommend that mark–recapture efforts continue at the Meziadin Fishway, Kwinageese River, and Damdochax Creek.

## C.12. Abundance of Skeena River Chinook Salmon in 2012 and in Prior Years

The numbers of Chinook salmon returning to the Skeena River were estimated using the proportion of Kitsumkalum River fish measured from genetic samples collected at Tyee and the estimates of the Kitsumkalum Chinook salmon escapement from an independent mark–recapture program. This summary includes results for six projects, the 2009 to 2012 annual projects and two retrospective projects that examined thirty years of data from 1979 to 2008.

The Skeena River has the second largest aggregate of Chinook salmon spawning populations in British Columbia and is one of the escapement indicator stocks defined by the CTC for North/Central British Columbia. Chinook salmon escapements to the Skeena River as reported by the CTC are represented by an index that includes approximately 20 populations surveyed annually using a variety of techniques. The Kitsumkalum River is the exploitation rate indicator stock for the Skeena Chinook salmon complex and spawning escapements have been estimated using a mark–recapture program since 1984. Other escapement estimates that contribute to the index are based on fish weir counts, visual observations from helicopter, fixed wing aircraft, boats and foot surveys. The index of Chinook salmon escapement to the Skeena aggregate has averaged 50,000 fish since 1984 (Table C.8). The Kitsumkalum River indicator stock represents approximately 30% of the spawners in the escapement index. The Bear and Morice river populations have contributed 20% and 26% of the escapement index respectively since 1984.

*Table C.8.–Skeena Chinook salmon escapement index, 1984–2012.*

| Year | Skeena Escapement Index | Year | Skeena Escapement Index | Year | Skeena Escapement Index |
|---|---|---|---|---|---|
| 1984 | 35,864 | 1994 | 22,611 | 2004 | 39,552 |
| 1985 | 52,407 | 1995 | 34,390 | 2005 | 29,496 |
| 1986 | 59,719 | 1996 | 73,684 | 2006 | 36,232 |
| 1987 | 60,948 | 1997 | 42,539 | 2007 | 36,754 |
| 1988 | 68,307 | 1998 | 46,774 | 2008 | 34,415 |
| 1989 | 57,192 | 1999 | 43,775 | 2009 | 36,176 |
| 1990 | 55,541 | 2000 | 51,804 | 2010 | 42,339 |
| 1991 | 52,792 | 2001 | 81,504 | 2011 | 34,130 |
| 1992 | 67,118 | 2002 | 44,771 | 2012 | 34,024 |
| 1993 | 68,286 | 2003 | 56,758 | | |

Skeena River Chinook salmon are encountered in the AABM fisheries in Southeast Alaska and Northern British Columbia. They also contribute to the ISBM fisheries in Northern British Columbia including gillnet, tidal sport, non-tidal sport, tidal First Nations and non-tidal First Nations fisheries. Skeena Chinook salmon are north migrating so they do not contribute to the West Coast Vancouver Island AABM fisheries nor do they contribute appreciably to ISBM fisheries south of the Skeena River.

The retrospective project estimated Chinook salmon returns to the Skeena River using genetic stock identification techniques of archived scale samples. In 2012, genetic analyses of 10,196 Chinook salmon were completed from 16,547 fish sampled at the Tyee Test Fishery over 13 years: 1984, 1990, 1992, 1994, 1995, 1996, 1999, 2000, 2001, 2003, 2006, 2007 and 2008. The proportions of Kitsumkalum River Chinook salmon identified in the annual samples were expanded to Skeena-wide population estimates using the return of Kitsumkalum Chinook salmon estimated from independent mark–recapture programs. The preliminary estimates of large Chinook salmon returning to the Skeena River as measured at Tyee ranged from 36,006 in 2012 to 155,474 in 2001. Over the full time series, the coefficients of variation around the preliminary estimates were less than the data standard of 15% in 12 years and were greater than 15% in 17 years (Table C.9; Figure C.2).

*Table C.9.–Preliminary escapement estimates for the aggregate of Skeena River Chinook salmon populations caught at Tyee from the 2011 and 2012 retrospective projects and for the 2009 to 2012 annual projects.*

| Year | Kitsumkalum Mark–Recapture Estimate | CV of Kitsumkalum Mark–Recapture Estimate | Weighted Proportion of Kitsumkalum at Tyee from DNA | CV of Kitsumkalum Proportion | Total Skeena Chinook Salmon Estimate | CV of Skeena Estimate |
|---|---|---|---|---|---|---|
| 1984 | 12,408 | 19.9% | 20.9% | 15.1% | 59,248 | 25.0% |
| 1985 | 8,304 | 5.9% | 20.2% | 12.4% | 41,175 | 13.7% |
| 1986 | 9,109 | 5.9% | 23.3% | 14.7% | 39,051 | 15.9% |
| 1987 | 23,657 | 10.1% | 14.9% | 14.3% | 158,774 | 17.5% |
| 1988 | 22,267 | 6.9% | 21.2% | 10.5% | 105,196 | 12.6% |
| 1989 | 17,925 | 7.2% | 21.9% | 10.5% | 81,822 | 12.8% |
| 1990 | 17,406 | 6.4% | 21.2% | 11.3% | 82,043 | 13.0% |
| 1991 | 9,288 | 7.2% | 17.3% | 11.7% | 53,640 | 13.7% |
| 1992 | 12,437 | 8.1% | 10.8% | 20.7% | 114,726 | 22.3% |
| 1993 | 14,059 | 5.5% | 10.9% | 16.1% | 129,349 | 17.1% |
| 1994 | 12,629 | 9.5% | 14.6% | 13.4% | 86,368 | 16.4% |
| 1995 | 7,221 | 10.1% | 10.6% | 22.3% | 67,996 | 24.5% |
| 1996 | 12,776 | 16.7% | 9.1% | 11.1% | 141,135 | 20.0% |
| 1997 | 5,342 | 11.3% | 8.4% | 15.9% | 63,657 | 19.5% |
| 1998 | 11,065 | 6.8% | 12.2% | 16.6% | 90,460 | 17.9% |
| 1999 | 9,763 | 8.9% | 14.2% | 7.9% | 68,763 | 11.9% |
| 2000 | 14,722 | 8.2% | 13.6% | 9.5% | 107,859 | 12.5% |

–continued–

Table C.9. Page 2 of 2.

| Year | Kitsumkalum Mark–Recapture Estimate | CV of Kitsumkalum Mark–Recapture Estimate | Weighted Proportion of Kitsumkalum at Tyee from DNA | CV of Kitsumkalum Proportion | Total Skeena Chinook Salmon Estimate | CV of Skeena Estimate |
|---|---|---|---|---|---|---|
| 2001 | 23,839 | 9.5% | 15.3% | 7.4% | 155,474 | 12.1% |
| 2002 | 23,849 | 11.4% | 25.0% | 5.3% | 95,442 | 12.6% |
| 2003 | 23,608 | 11.0% | 18.9% | 6.9% | 124,818 | 13.0% |
| 2004 | 25,767 | 10.2% | 16.8% | 7.8% | 153,065 | 12.8% |
| 2005 | 15,046 | 9.2% | 17.8% | 7.0% | 84,470 | 11.6% |
| 2006 | 12,368 | 14.5% | 13.7% | 9.3% | 90,434 | 17.2% |
| 2007 | 15,736 | 18.0% | 17.5% | 7.5% | 89,995 | 19.5% |
| 2008 | 10,374 | 14.2% | 13.1% | 8.2% | 79,333 | 16.4% |
| 2009 | 10,703 | 13.3% | 12.4% | 13.3% | 86,476 | 18.8% |
| 2010 | 13,712 | 14.8% | 12.7% | 10.2% | 107,601 | 18.0% |
| 2011 | 12,059 | 20.2% | 21.0% | 6.8% | 57,446 | 21.3% |
| 2012 | 9,363 | 13.9% | 26.0% | 7.8% | 36,006 | 16.0% |

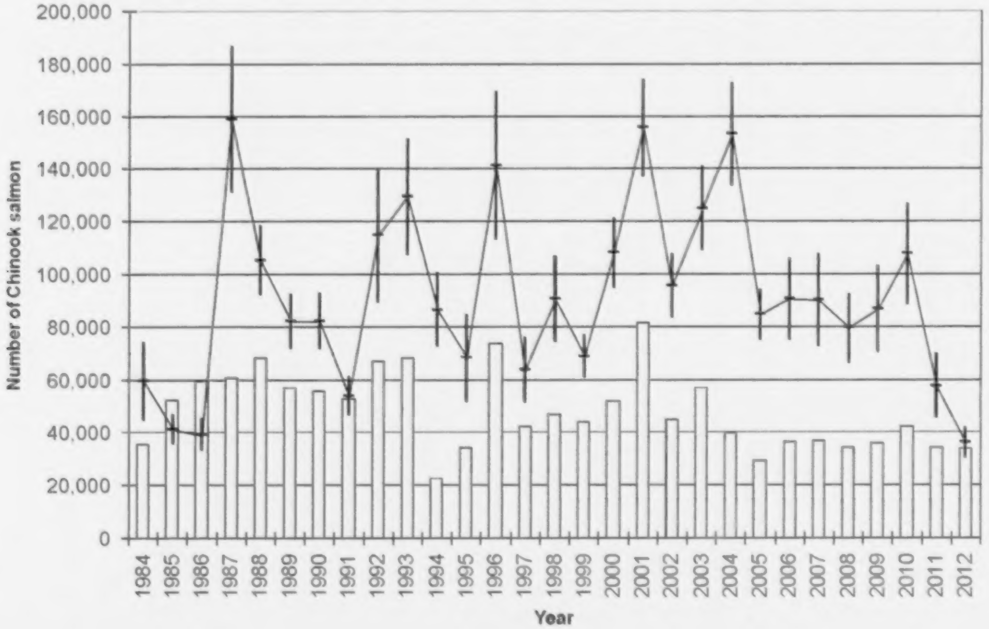

*Figure C.2.–Comparison of the number of Chinook salmon estimated past Tyee using the genetic approach with the Skeena River Chinook salmon escapement index.*

*Note: The bars represent the Skeena River Chinook salmon escapement index. The crosses represent the estimates generated using the genetic approach. The vertical lines represent the genetic estimates plus and minus one standard deviation.*

These results are preliminary as modifications are scheduled for the genetic baseline for Skeena River Chinook salmon populations. The ultimate objective is to provide aggregate escapement estimates for the complete time series from 1979 to 2013. Genetic stock identifications have been completed for 1,056 samples from the Tyee Test Fishery from 1979 to 1983.

While these efforts failed to meet the CTC data standard in 17 of 29 years, the estimates represent an improvement over existing indices since comparisons may be made between years (Figure C.2) and across component stocks. Further, the estimates include estimates of variance. Variance estimates cannot be produced for the escapement indices of Skeena River Chinook salmon because of the combinations of different escapement techniques involved. The technique that has been used represents a relatively frugal way to estimate the Chinook salmon return to the Skeena River aggregate. It is probable that the program will be continued after the SSP program ends.

# APPENDIX D. BILATERAL DATA STANDARDS FOR ESTIMATES OF ESCAPEMENT FOR CHINOOK SALMON ESCAPEMENT INDICATOR STOCKS

In 2008, the CTC adopted data standards for escapement indicator stocks: escapement estimates should be asymptotically accurate (unbiased), and, as a planning goal, escapement estimates for a stock should average a CV of 15% or less. The documentation of that action is provided herein.

CHINOOK (King)
Oncorhynchus tshawytscha

# PSC Chinook Technical Committee

**TO:** Sentinel Stocks Committee

**FROM:** John Carlile, Rick McNicol, and Rishi Sharma: CTC Co-chairs

**DATE:** October 29, 2008

**SUBJECT:** Bilateral Data standards for Estimates of Escapement for Chinook Escapement Indicator Stocks

After analysis, review, and discussion, the bilateral CTC has determined two bilateral data standards for estimating spawning escapement:

1) individual estimates of total spawning escapement for a stock should on average attain an estimated coefficient of variation (CV) of 15% or less; and

1) specific estimates of spawning escapement shall be derived with demonstrably asymptotically accurate methods[1], i.e. methods that produce unbiased estimates.

The CTC does not intend that the first standard be used to judge the relevance of the results from past or future studies to managing fisheries under the PST. Given the difficulties and cost of estimating escapement, the CTC felt that the first standard should be treated more as a goal for planning. Results from recent studies to estimate spawning escapement in Oregon, Canada, Alaska, and Washington (see Attachment 1) indicate that the first data standard (a CV of 15% or better) does represent a realistic goal for planning.

These two data standards were decided according to how estimates of spawning escapement will be used to manage salmon fisheries under the new agreement. Four uses were identified: triggering additional management action under paragraph 13, developing escapement goals, exploitation-rate analysis, and forecasting run size. Relative to paragraph 13, a CV of 15% or less in estimates of escapement was shown (in an analysis presented to the CTC) to correspond to an acceptable risk (one year or one stock in six) of failing to label a stock of concern when warranted (see Attachment 2). Another analysis submitted to the sub-committee showed that a CV of 15% or less also avoided bias in stock-recruit analyses used to develop escapement goals (see Attachment 3). After discussion the CTC decided that considering exploitation-rate analysis and forecasting run size in determining data standards for escapement estimates is premature. No bilateral data standards as yet exist for exploitation rates or forecasts. Once these standards have been established, data standards for escapement estimates can be reevaluated.

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[1] In this context, a method of estimating spawning escapement is 'asymptotically accurate' if the difference between the estimate and the actual escapement decreases to zero as the number of salmon sampled in the study increases.

We hope that these bilateral data standards are sufficient for your use in the SSP. Please contact us if they are not. Also, feel free to contact Rick McNicol, Ethan Clemons, Ed Jones, Marianna Alexandersdottir, or Dave Bernard if you have any questions concerning the attachments.

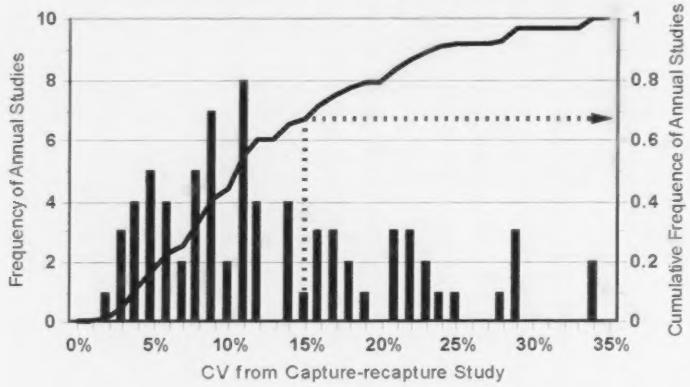
Attachments (3)

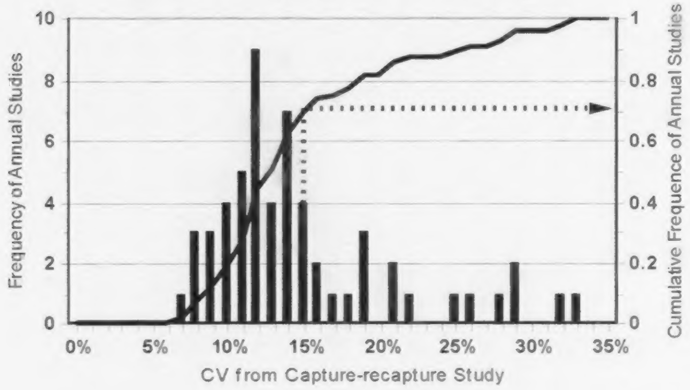
**Attachment 1**: Note that estimates in this attachment result from capture-recapture experiments, only one of several possible methods of estimating escapements. Relative variation from such experiments is comparable to the first data standard (a CV of 15% or better) only if there is no spawning downstream of the experiment or if there are no removals upstream or within the area covered by the experiment. If for instance a fishery or hatchery occurs upstream of, or within the study area, the estimate from the capture-recapture experiment needs to be reduced by the number of fish 'leaving' the river before a CV appropriate to spawning escapement can be calculated. Also, precision in estimates from capture-recapture experiments designed to produce expansion factors for index surveys do not represent all the imprecision in subsequent expanded estimates of spawning abundance.

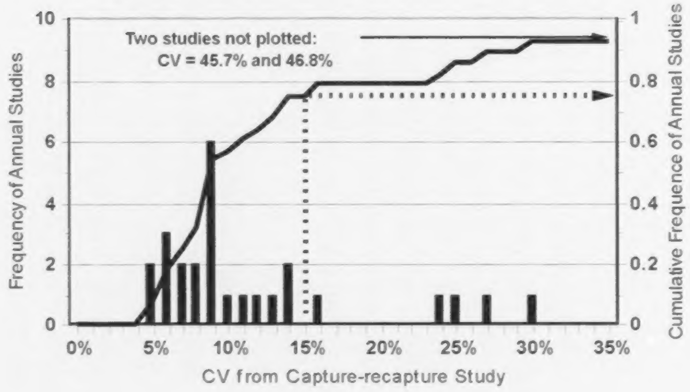
| Stocks w/ capture-recapture studies: | | |
|---|---|---|
| **Canadian Stocks** | **Southeast Alaska** | **Oregon** |
| Burman | Alsek | Coos (SF) |
| Dean | Blossom | Coquille |
| Harrison | Chickamin | Nehalem |
| Kaouk | Keta | Nehalem (NF) |
| Kateen | Stikine | Siletz |
| Kitsumkalum | Taku | Siuslaw |
| Kwinamass | Unuk | Umpqua |
| Leiner | | |
| Lower Shuswap | | |
| Marble | | |
| Middle Shuswap | | |
| Nicola | | |
| Tahsis | | |
| Tranquil | | |

The Green River Stock is the sole representative of Washington stocks in this attachment. Studies in 2000, 2001, and 2002 on the Green stock produced estimates of abundance of 12,952 (CV = 12.1%), 22,855 (CV = 6.8%), and 16,258 (CV = 8.6%) for adults age 2 and older.

Attachment 1 (continued).

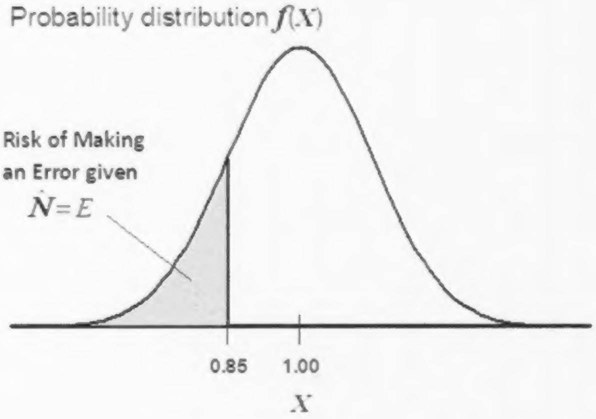

Canadian Stocks (14) from 1984-2007


SEAK Stocks (7) from 1989-2007


Oregon Stocks (7) from 1998-2007

**Attachment 2**: One use for estimates of spawning escapement in managing AABM and ISBM fisheries under the new agreement in the Pacific Salmon Treaty is to trigger action under paragraph 13. The management objective for escapement indicator stocks under the treaty is to realize an annual escapement *N* that is equal to an escapement goal *E*. Unless annual escapement is a count, the escapement goal is compared to an estimate $\hat{N}$ instead of *N* for the purpose of the paragraph. Because *N* is estimated, there is some uncertainty in its value; there is a chance (risk) that *N* may be below 85% of the escapement goal laid out in the paragraph as a threshold for labeling a stock of concern, even though $\hat{N} = E$. The relationship between how much of this risk is acceptable and the precision of $\hat{N}$ can be used to develop a datum standard for $\hat{N}$.

Transformations can be used to link risk of management error to precision. The probability of *N* given that $\hat{N} = E$ can follow a near normal probability distribution with mean *E* and a variance for *N*. If such a variable *N* is divided by the constant *E*, the result is a normally distributed variable *X* with mean $1(=\hat{N}/E = E/E))$ and variance $Var(N)/E^2$ (see inset). The normal probability distribution for *X* can be transformed into the standard normal variate *Z* by dividing the square root of *Var*(*X*) into the difference between the threshold and the expected escapement (–0.15 = 0.85 – 1). Note that in this circumstance that $Var(X) = CV^2(X) = CV^2(N)$ which means that $Z = -0.15/CV(N)$. If α is the risk (probability) of management error, then precision as function of that risk for this problem would be:



$$CV(N) = \frac{0.15}{Z_\alpha}$$

Note that because the standard normal is symmetric, the negative sign in the above calculation can be ignored.

Plugging in values of $Z_\alpha$ from a standard normal table into the equation above produces the three levels of precision for $\hat{N}$ in the form of $CV(N)$:

| $\alpha \times 100\%$ | **Odds of Making an Error** | $Z_\alpha$ | $CV(N)$ |
|---|---|---|---|
| 5% | 1 in 20 years/stocks | 1.645 | 0.09 |
| 10% | 1 in 10 years/stocks | 1.285 | 0.12 |
| 16.6% | 1 in 6 years/stocks | 0.970 | 0.15 |
| 20% | 1 in 5 years/stocks | 0.845 | 0.18 |

The odds of making an error could be expressed from the perspective of one stock over time (1 in *n* years) or within one year over many stocks (1 in *k* stocks). A CV of 15% has proven to be a do-able standard for many studies to estimate escapement of Chinook salmon (see Attachment 1). Of course, the risk is less than expressed for the same CV if $\hat{N} > E$, and more so if $0.85E < \hat{N} < E$.

**Attachment 3:** Another use for estimates of spawning escapement in managing AABM and ISBM fisheries under the new agreement in the Pacific Salmon Treaty is to develop production models with which to establish escapement goals. While there are many ways in which information on past escapements can be used to produce defensible goals for management, this discussion is restricted to only one: analysis to avoid bias and improve precision in optimal escapement goals from estimated stock-production relationships.

A stock-production model, like the Ricker model $[\ln(R_{by}/N_{by}) = a - bN_{by} + \varepsilon_{by}]^2$, is "fit" to data on production *R* and escapement *N* to produce estimates for parameters *a* and *b*. These statistics are then rearranged to estimate the optimal escapement goal $\hat{N}_{MSY} \cong (\hat{a}'/\hat{b})(0.5 - 0.07\hat{a}')$ where $\hat{a}' = \hat{a} + \hat{\sigma}^2/2$ (for the Ricker model).

Uncertainty in past escapements ($N_{by}$) affects the accuracy and precision of $\hat{N}_{MSY}$ (see Kehler et al. 2002)[3]. As part of a short course on developing escapement goals, the Alaska Department of Fish and Game[4] ran a series of simulations to determine the extent that uncertainty in escapements affects escapement goals. Simulations recreated a series of data sets $\{\hat{R}, \hat{N}\}$ with parameter values typical of Chinook stocks ($a \leftarrow 2$, $b \leftarrow 0.001$, and $\sigma \leftarrow 0.5$) and with $CV(N) \leftarrow \{0; 0.05; 0.1; 0.15; \ldots\ 0.50\}$. Harvest rates used to recreate the simulated data sets were set at high (~80%), moderate (~50%), low (~20%), and mixed (20% to 80%). In the inset figures below the vertical blue bars represent the actual uncertainty in $\hat{N}_{MSY}$ and the vertical red bars the estimated uncertainty (red and blue bars cover the 10 to 90 percentiles for simulations). The blue hash marks on the blue bars represent the averages of the $\hat{N}_{MSY}$ in the simulations while the dotted blue line connects the medians of the $\hat{N}_{MSY}$. The black bar across each plot represents the true value of $N_{MSY}$.

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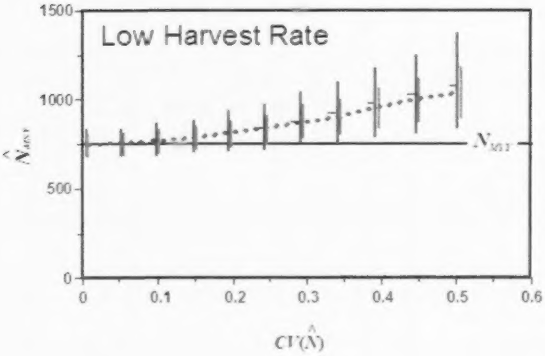
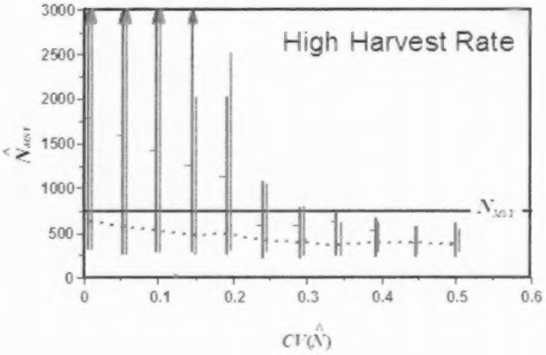
[2] Notation: $N_{by}$ is the escapement in brood year *by*, *R* is the subsequent production in adults from that escapement in the absence of fishing, and $\varepsilon$ is a random normal variate with mean 0 and variance $\sigma^2$.

[3] Kehler, D. G., R. A. Myers, and C. A. Field. 2002. Measurement error and bias in the maximum reproductive rate for the Ricker model. Canadian Journal of Fisheries and Aquatic Sciences 59:854–864.

[4] We wish to give credit here to Steven Fleischman, a Fisheries Scientist with the Division of Sport Fish, ADF&G, for his comprehensive work with these simulations. Steve's insights on the matter of measurement error and its effects on developing escapement goals were (are) essential to the success of this short course. Steve can be reached at Steve.Fleischman@alaska.gov.





If data are "collected" when harvest rates had been low, uncertainty from estimating escapements tends to make $\hat{N}_{MSY} > N_{MSY}$ and escapement goals too high, especially when $CV(\hat{N}) > 0.20$. The reverse is true if harvest rates had been high during data collection; resulting escapement goals would promote recruitment overfishing because $\hat{N}_{MSY} < N_{MSY}$. Fortunately, estimated imprecision in $\hat{N}_{MSY}$ is so great when $CV(\hat{N}) \leq 0.20$ and harvest rates high, no goal would likely be developed under these circumstances. The real danger in analyzing data collected during a period of high harvest rates occurs when $CV(\hat{N}) > 0.20$; precision of $\hat{N}_{MSY}$ looks good, but the value of $\hat{N}_{MSY}$ is well below the true value. Results from simulations under moderate and mixed harvest rates were not provided here because values of $CV(\hat{N})$ had negligible effects on bias ($\hat{N}_{MSY}$ *vs.* $N_{MSY}$). Uncertainty in $\hat{N}_{MSY}$ did increase with increase in $CV(\hat{N})$ when harvest rates had been moderate or mixed, but these increases are similar to increases experienced when harvest rates had been low (see above). Regardless of the harvest rates in effect when data were collected, true uncertainty in $\hat{N}_{MSY}$ is understated whenever escapements had been estimated.

Simulations above show that a $CV(\hat{N})$ of about 0.15 to 0.20 would be a good standard relative to setting escapement goals. At that $CV(\hat{N})$ or lower, bias and imprecision in the goal would likely be negligible if that goal was developed from data collected under all but a regime of high harvest rates. Under such a regime, a $CV(\hat{N}) \leq 0.15$ would produce a goal so obviously imprecise as to be unusable, thereby avoiding recruitment overfishing that would occur if a goal had been developed under these circumstances.

# APPENDIX E. BILATERAL DATA STANDARDS FOR ESCAPEMENT GOALS

In 2013, the CTC adopted data standards for MSY or other biologically-based escapement goals. The documentation of that action, CTC Technical Note 1301, is provided herein.

## Bilateral Data Standards for MSY or Other Biologically-Based Escapement Goals

### CTC Technical Note 1301

### June 7, 2013

In Chapter 3, section 2(a)(ii) commits the "Parties" to harvest regimes for Chinook salmon that are

> *"... designed to meet MSY or other agreed biologically-based escapement and/or harvest rate objectives; with the understanding that harvest rate management is designed to provide a desired range of escapement[1] over time;"*

The CTC judges objectives as being biologically based by reviewing biological evidence and scientific arguments that the objective is expected to produce MSY or some other specified yield consistent with the intent of the Treaty. Acceptance of the objective by the CTC will depend on evidence and arguments meeting certain standards.

Precision in management objectives such as escapement goals or exploitation rates have no standard, but the CTC requires that uncertainty be reported. Most escapement or exploitation-rate objectives are functions of many other estimates resulting from different observational studies controlled by separate agencies under various jurisdictions. For these reasons, a single agency cannot control the precision of the objective and a standard for precision is not realistic. Multiple agencies typically contribute fishery data to estimate production, and those agencies often have different resources, sampling designs, and objectives for their catch sampling programs. What we have is what we use, so long as it is accurate. Still, precision is related to uncertainty, so the CTC requires some estimate of uncertainty surrounding the objective—a CV, SE, CI, credible set, and/or posterior distribution are examples.

The standard for accuracy for an objective is evidence that the expected result will on average be attained if the objective is met. The expected result is MSY or another outcome that is consistent with the treaty; the objective is a point value or range of escapements or harvest rates determined from data. Evidence in support of an accurate objective largely depends on how the objective was determined. The balance of this technical note pertains to evidence required for some standard methods: stock-recruit analysis, habitat models, and life-history/ecosystem models.

### 1. Stock-Recruit Analysis (SRA)

When an escapement or exploitation rate objective is to be confirmed through SRA, and this objective is intended for use in application of Chapter 3 of the 2009 Agreement, the methodology used should be consistent with Chapter 1: General Methods for Stock-Recruit Analysis in CTC (1999). During bilateral review of escapement objectives, the CTC has employed a checklist to judge consistency with CTC (1999). That checklist has been modified to address the expectation that methods employed are likely to produce accurate escapement or harvest rate objectives. The checklist of questions for SRA includes:

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[1] Here escapement is defined as the abundance of adult spawners.

1) Do escapement and production estimates have measures of uncertainty[2]?
2) Is production measured in adult equivalents and/or smolts?
3) Do the escapement and recruitment estimates exclude jacks (youngest age for spawners)? If they are included, were they accurately estimated?
4) Have production estimates been reduced for any hatchery-produced fish on the spawning grounds?
5) Are total fishing-induced mortalities and escapements estimated by age class?
6) Is production in adults expressed in terms of adult equivalents?
7) If contrast in spawning stock size is insufficient (i.e., <4) for SRA[3], was information from other sources used to complete the SRA (see Sections 2 and 4 for examples).
8) In the choice of a compensatory stock-recruit model[4]:
    a) Does the stock-recruit model have multiplicative process errors?[5]
    b) Is the process error stationary (no discernible trend over time)?
    c) If a density independent covariate is included in the model, was the covariate appropriately modeled?
    d) If the stock-recruit model includes depensatory elements, was a reasonable scientific justification presented for the inclusion?
9) For estimated parameters and reference points:
    a) Was the stock-recruit model correctly fit to the data?
        i. If estimates of escapement and production contain measurement error, was the error in estimates addressed in the fit?
        ii. If serial correlation is evident in errors, was the correlation modeled correctly?

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[2] Uncertainty in production and/or escapement estimates arises from sampling, is referred to as "measurement error", and is usually expressed as a sampling variance or mean-squared error.

[3] See CTC (1999) for criteria.

[4] Ricker's model is the preferred option for escapement objectives, Beverton-Holt's model addresses harvest rate objectives, but other models may be used if justified with reasonable arguments and evidence.

[5] The term "process errors" refers to deviations between realized and expected production from the stock-recruit relationship due to density-independent natural causes.

iii. If log-transformations were involved in calculating parameter estimates, were the calculations adjusted accordingly?

iv. Are the data sufficient to estimate the stock-recruit model? If not, what is the basis for the escapement objective (e.g., spawning escapement range, escapement floor, etc.)

b) Is the escapement or harvest rate objective reasonable given its uncertainty[6]?

10) Are escapement or harvest rates likely to be estimated in years to come for the stock, in units comparable to those used to generate the objective?

The accuracy standard is most likely met if answers are "yes" to questions 1–6, 7a–d, and 8a (i–iii). Answers to question 8b and 9 should also be "yes". While not related to accuracy of the methods employed, escapement or harvest rate objectives without a measure of uncertainty are not acceptable to the CTC.

SRA based on traditional statistical regression has a long history in management of salmon fisheries (Hilborn and Walters 1992). Recently Bayesian analysis has been developed to estimate reference points in an SRA (Adkison and Peterman 1996, Millar and Meyer 2000, Fleischman et al. 2013). Bayesian analysis using state-space models can be used to determine escapement or exploitation rate objectives with SRA (Bernard and Jones 2010 as an example brought before the CTC). Regardless of the type of SRA employed, a "yes" answer to all or most of the items on the check list above indicates that the objective most likely represents an accurate reference point. Once the management objective has been accepted, the CTC expects to review the objective periodically in the future to ensure that recent population dynamics are represented.

## 2. Habitat Models

The CTC has accepted escapement objectives based upon the work of Parken et al. (2006) and Liermann et al. (2010). In both studies, empirical relationships are developed between reference points estimated for stock-recruit relationships, life history, and size of natal watersheds for Chinook salmon stocks. Reference points for escapement associated with MSY ($S_{MSY}$) and carrying capacity ($S_{EQ}$) were estimated as functions of watershed size ($km^2$) for 25 stocks from central Alaska to the north Oregon Coast. Parken et al. 2006 provided four relationships predicting two reference points ($S_{MSY}$ or $S_{EQ}$) for two life-history types (stream-type or ocean-type) as functions of watershed size. Liermann et al. (2010) provided one relationship estimated with Bayesian regression to simultaneously produce posterior distributions for both reference points as functions of watershed size using the same data as Parken et al. (2006). The checklist for this approach includes:

1) Was watershed size[7] correctly measured?

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[6] "Uncertainty" results from process error and measurement error combined.

2) Was the relationship appropriate for the life history?

3) Is the quality of the freshwater habitat for the stock in question similar to the quality of habitats for the stocks in Parken et al. (2006)?

4) Were calculations correct?

5) Is the objective reasonable given its uncertainty?

6) Are annual escapements measured in the same units used by the model[8]?

7) Are escapements or harvest rates likely to be estimated in years to come?

If the answers to the first four questions are "yes", the accuracy standard will most likely be met for both escapement and harvest rate objectives designed to produce MSY or near MSY. While an estimate of $S_{MSY}$ and a measure of uncertainty of that estimate may be calculated directly from Parken et al. (2006) under these circumstances, an estimate of the exploitation rate associated with MSY ($U_{MSY}$) has to be calculated as a function of the estimates for $S_{MSY}$ and $S_{EQ}$. If the answers are "yes" to the first and third questions on the checklist, but "no" to the second, the accuracy standard requires evidence of the degree to which intrinsic productivity[9] is lower or higher than the average calculated from Parken et al. 2006.

Use of reference points and parameters derived from Parken et al. (2006) can be used as "priors" in a Bayesian SRA. In many instances, stock data have been collected during periods of high or low exploitation. Under high exploitation, the data will contain little information concerning carrying capacity, making estimates of $S_{EQ}$ and $S_{MSY}$ problematic. In contrast, a history of low exploitation contains little information on intrinsic productivity. Using the habitat model of Parken et al. 2006 to produce priors for these two parameters is encouraged [see Bernard and Jones (2011) for an example].

### 3. Life-history/Ecosystem Models

For some time, life-history models have been proposed to guide management of salmon fisheries (Moussalli and Hilborn 1986, AFS 2009) and along with ecosystem models, proposed to guide planning involved with habitat restoration (SHIRAZ by Scheuerell et al. 2006; EDT by Lichatowich et al. 1995, Mobrand et al. 1997, and McElhany et al. 2010). Both approaches have potential to provide accurate escapement or harvest rate objectives, especially under conditions of compromised habitat. However, this potential is difficult to realize because both

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[7] From Parken et al. (2006), watershed size is the area upstream of the mouth excluding any area no longer accessible to Chinook salmon because of the acts of man, and any area upstream of natural barriers to passage on 4th order streams if the stock has a stream-type life history, or on 5th order streams if the stock has an ocean-type life history.

[8] Escapements for ocean-type Chinook are measured in age 3 and older and for stream-type as age 4 and older.

[9] In the context of an empirical stock-recruit relationship in the usual formulation of Ricker's or Beverton and Holt's models, the parameter  represents intrinsic productivity.

approaches tend to be over parameterized. As reported by McElhany et al. (2010) in regards to the ecosystem model EDT:

> "The (our) analyses indicated that as a consequence of internal parameter uncertainty, EDT productivity and capacity predictions lack the precision needed for many management applications."

Under these circumstances the checklist includes:

1) Was the model calibrated with parameters adjusted to "fit" observed statistics for the stock?
2) Do observed statistics have measures of uncertainty?
3) Were parameters from the calibrated model within expected norms for the stock?
4) Were reference points predicted from the calibrated model validated with reference points derived independently and are predictions from two methods similar?
5) Is the objective reasonable given uncertainty?
6) Are escapements or harvest rates likely to be estimated in years to come?

A time-series of escapement estimates is an example of observed statistics used to calibrate the model. A value >20 for a parameter representing intrinsic productivity derived from a calibration would be outside the norm for that parameter. A prediction of carrying capacity from a calibrated life history/ecosystem model that matches the prediction from the habitat model would validate the former model.

If the answers to questions 1–5 are "yes", the accuracy standard has most likely been met.

### 4. Other Approaches

Standards listed above for accepting harvest rate or escapement objectives as biologically based are not exclusive and the CTC will consider objectives developed from different approaches. Acceptance of such objectives will depend on the same general criteria used in the above methods, and will be based on arguments for accuracy of estimates, the logic of arguments, and scientific validation of the analysis.

The accepted escapement objective for Chilkat River Chinook in Alaska is an example of the CTC accepting non-standard methods as having produced an accurate escapement objective (see Ericksen and McPherson 2004). Escapements for this stock were accurately estimated for a number of consecutive years when harvest rates were low (average 12%). Under this circumstance the mean of escapement estimates was considered a reasonable proxy of carrying capacity for the stock. Ratios of $S_{MSY}/S_{EQ}$ estimated for other stocks in Southeast Alaska were averaged to get an estimate of the ratio for the Chilkat stock. The mean ratio was then multiplied by the estimate of carrying capacity for the Chilkat stock to calculate an escapement objective based on MSY.

## References Cited

Adkison, M. D., and R. M. Peterman. 1996. Results of Bayesian methods depend on details of implementation: an example estimating salmon escapement goals. Fisheries Research 25(2):155–170.

(AFS) American Fisheries Society. 2009. Pacific salmon environmental and life history models: advancing science for sustainable salmon in the future. E. E. Knudsen and J. Hal Michael, Jr. editors. American Fisheries Society Symposium 71.

Bernard, D. R., and E. L. Jones III. 2010. Optimum escapement goals for Chinook salmon in the transboundary Alsek River. Alaska Department of Fish and Game, Fishery Manuscript Series No. 10-02, Anchorage.

CTC. 1999. Maximum sustained yield or biologically based escapement goals for selected Chinook salmon stocks used by the Pacific Salmon Commission's Chinook Technical Committee for escapement assessment. Volume 1. TCCHINOOK (99)-3. Pacific Salmon Commission. Vancouver, BC.

Ericksen, R. P., and S. A. McPherson. 2004. Optimal production of Chinook salmon from the Chilkat River. Alaska Department of Fish and Game, Fishery Manuscript No. 04-01, Anchorage.

Fleischman, S. J., M. J. Catalano, R. A. Clark, and D. R. Bernard. 2013. An age-structured state-space stock-recruit model for Pacific salmon (*Oncorhynchus* spp.). Canadian Journal of Fisheries and Aquatic Sciences 70:401–414.

Hilborn, R. A. and C. J. Walters. 1992. Quantitative fisheries stock assessment. Chapman and Hall. New York.

Lichatowich, J., L. Mobrand, L. Lestelle, and T. Vogel. 1995. An approach to the diagnosis and treatment of depleted Pacific salmon populations in Pacific Northwest watersheds. Fisheries 20:10–18.

Liermann, M. C., R. Sharma, and C. K. Parken. 2010. Using accessible watershed size to predict management parameters for Chinook salmon, *Oncorhynchus tshawytscha* , populations with little or no spawner-recruit data: a Bayesian hierarchical modelling approach. Fisheries Management and Ecology 17(1):40–51.

McElhany, P., E. A. Steel, K. Avery, N. Yoder, C. Busack, and B. Thompson. 2010. Dealing with uncertainty in ecosystem models: lessons from a complex salmon model. Ecological Applications 20:465–82.

Millar, R.B., and R. Meyer. 2000. Bayesian state-space modeling of age-structured data: fitting a model is just the beginning. Canadian Journal of Fisheries and Aquatic Sciences 57:43–50.

Mobrand, L., J. Lichatowich, L. Lestelle, and T. Vogel. 1997. An approach to describing ecosystem performance "through the eyes of salmon". Canadian Journal of Fisheries and Aquatic Sciences 54:2964–2973.

Moussalli, E., and R. Hilborn. 1986. Optimal stock size and harvest rate in multistage life history models. Canadian Journal of Fisheries and Aquatic Sciences 43:135–141.

Parken, C. K, R. E. McNicol, and J. R. Irvine. 2006. Habitat-based methods to estimate escapement goals for data limited Chinook salmon stocks in British Columbia, 2004. Canadian Science Advisory Secretariat Research Document 2006/083. http://www.dfo-mpo.gc.ca/csas/

## References Cited (Continued)

Scheuerell, M. D., R. Hilborn, M. H. Ruckelshaus, K. K. Bartz, Kerry M. Lagueux, Andrew D. Haas, and Kit Rawson. 2006. The Shiraz model: a tool for incorporating anthropogenic effects and fish–habitat relationships in conservation planning. Canadian Journal of Fisheries and Aquatic Sciences 63:1596–1607.